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Enhancing everyday memory and participation in multiple sclerosis: A pilot study of a metacognitive strategy-based intervention

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Abstract

Background: Cognitive dysfunction in individuals with multiple sclerosis (MS) is associated with limitations in daily activities and restricted participation. Existing interventions for cognitive dysfunction often show inconsistent transfer to everyday activities and typically require frequent clinic visits, which can be challenging for patients with MS due to mobility issues. To address this barrier, we developed a telehealth-based cognitive intervention that is based on metacognitive strategy training.

Objective: Examine the feasibility and impact of a telehealth-based cognitive intervention on activity and participation in persons with MS.

Methods: Ten participants with MS were included in a remote six-week, 12 sessions cognitive treatment program. The treatment emphasized self-generation and metacognitive strategies to enhance cognitive function. Participants' cognitive abilities were evaluated at baseline (Time 1), midtreatment (Time 2), and posttreatment (Time 3).

Results: Participants demonstrated improved memory, self-awareness, strategy use, and functional status. Participants reported enhanced confidence and better focus and found the remote program engaging and applicable to daily life, reporting increased preparedness for learning.

Conclusion: Results provide preliminary proof-of-concept data suggesting that telehealth-based cognitive intervention is well accepted by patients and may improve cognitive functions in persons with MS. These data support the need for a larger trial for this intervention.

Keywords: Cognitive rehabilitation, coping strategies, metacognition, activities of daily living, quality of life, feasibility studies

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Introduction

Cognitive dysfunction in persons with multiple sclerosis (MS),[1] particularly learning and memory,[1,2] limits activities of daily living (ADL),[3] employment, and participation.[4,5] Therefore, cognitive treatment is crucial for individuals with MS who are dealing with cognitive challenges.[6]

There are several cognitive intervention trials aimed at improving specific cognitive skills affected by MS, such as processing speed,[7] working memory,[8] and episodic memory.[9] Many of these interventions are based on two distinguished approaches: computerized cognitive training and strategy training.[6,10] Computerized cognitive training enhances cognitive functions through repetitive practice but shows limited generalization to everyday life activities.[11] Strategy training teaches cognitive strategies to minimize the effects of cognitive impairment on daily life.[10] One cognitive strategy, self-generation, enhances learning and memory by requiring individuals to actively produce information (e.g., creating a unique meaning, story, or association with the learned information) rather than passively receive it, leading to deeper encoding and improved recall.[12] While effective in MS,[13,14] its application in daily

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life remains challenging, highlighting the need for extended practice and generalization support. In two recent studies, participants were taught a cognitive strategy (i.e., self-generation to help acquire new information within a metacognitive strategy-based intervention.[9,15] The treatment, the self-GEN protocol, included six sessions and demonstrated improved strategy use and memory following in-person[9] and virtual[15] treatments. However, most participants stated they needed more practice to apply the strategy effectively in daily life.

In the current study, we added six more treatment sessions to the original self-GEN treatment protocol for a total of 12 sessions. These additional treatment sessions are based on the multicontext training approach, with the aim of increasing participants' awareness of cognitive performance while facilitating the application of the self-generation strategy across a range of functional tasks and everyday activities.[16] This pilot study explores the feasibility of a remote strategy-based, multicontext treatment approach combining the self-GEN with a metacognitive strategy-based intervention. The study examines clinical changes from pre- to posttreatment in self-awareness, self-regulation, memory, everyday memory, and increased engagement in ADL among patients with MS. The study also evaluates whether the additional six sessions contribute to these changes, providing insight into the effectiveness of extending the intervention duration.

The study research questions were: (a) What are the pretreatment to posttreatment changes in self-awareness and self-regulation among individuals with MS participating in the intervention? (b) Does the intervention impact everyday memory in individuals with MS? (c) Does engagement in ADLs change from pretreatment to posttreatment? (d) Do the additional six sessions contribute to further improvements in the study outcomes? (e) What is the feasibility (i.e., recruitment, adherence, fidelity, acceptability, and applicability) of implementing the metacognitive strategy-based intervention, and what are the perceived benefits and challenges reported by MS patients participating in the remote strategy-based treatment?

Methods

Participants

Between May and November 2023, 14 individuals diagnosed with MS[17] were recruited from the community by flyers, neurologist referrals, and word-of-mouth. Participants were 18 or older, had internet connectivity at home or work and the ability to use Zoom, and self-identified concerns regarding cognition, particularly everyday memory. For those referred by neurologists, inclusion involved individuals identified by the neurologist as experiencing cognitive and memory impairments. Exclusion criteria involved visual deficits that could hinder the reading of study materials and language barriers preventing comprehension, and an inability to provide informed consent, as indicated by the participant's failure to explain the study's purpose and procedures. The final sample consisted of 10 participants, predominantly female ($n = 8$), with more than 12 years of education. Table 1 displays participants' demographic and clinical characteristics. All procedures were approved by the New York University Institutional Review Board.

Intervention

The intervention was comprised of a six-week program of 12, 1–1.5-h treatment sessions, conducted twice weekly by an occupational therapist via Zoom. The first six sessions focused on teaching self-generation strategies while building awareness. These sessions are detailed in other studies.[9,15] Briefly, participants were introduced to the self-generation strategy, which posits that individuals retain information more effectively when self-generated rather than received from someone else.[12] In each session, participants practiced self-generation using a metacognitive approach, reinforcing their understanding and application of the strategy.

The additional six treatment sessions involved structured simulated functional tasks,[18] addressing specific cognitive challenges focusing on everyday memory and working memory. These sessions aimed to master the self-generation strategy while enabling participants to utilize a broader spectrum of strategies, reinforcing self-monitoring, self-evaluation, problem-solving, and strategy optimization. Rather than relying on self-generation alone, these additional sessions allowed participants to learn and apply various strategies suited to different situations, enhancing their ability to manage daily tasks and improving overall cognitive functioning.

All activities followed a sequential progression, gradually increasing the demand for the ability to transfer and generalize the use of strategies. During each session, participants were provided with an everyday activity involving two tasks with similar but not identical cognitive demands to ensure mastery (see

Table 1. Cohort demographics ($N = 10$).

	M (SD)	Range	Median
Age	58.6 (8)	47–72	56
Education	15.2 (1.8)	12–18	15.5
Sex (self-identified)			
Female	8		
Marital status (*n*)			
Divorced	4		
Married	3		
Widowed	2		
Single	1		
Employment (*n*)			
Disability	8		
Retired	1		
Full time	1		
Type of MS (*n*)			
Relapsing Remitting	2		
Secondary progressive	5		
Primary Progressive	3		
Duration of MS (years)	19.7 (5.5)	7–25	21.5
IADL score	5.2 (1.8)	3–8	5
PDDS	5.6 (1.8)	2–7	6.5

IADL: Instrumental Activities of Daily Living; MS: multiple sclerosis; PDDS: Patient-Determined Disease Steps.

Table 2). Importantly, the cognitive demands of activities did not increase in difficulty from session to session; instead, the range of application increased across treatments.

In all 12 treatment sessions, the therapist guided participants in anticipating and resolving performance issues, evaluating strategies, and connecting these activities to real-life situations. Methods aimed at enhancing self-monitoring and self-regulatory skills were integrated throughout each session. Prior to each activity, participants were prompted to predict obstacles, assess perceived difficulty, and describe the strategy they intended to use to enhance performance. After the activity, participants were asked questions about their perception of performance, encountered obstacles, and the benefits of the employed strategy. Each session concluded with a journaling task in which participants were asked what was helpful during the treatment, what was learned, and how it can be applied in everyday life. Each subsequent session started with the journal review, ensuring a continuous and personalized progression throughout the intervention. The therapist actively encouraged participants to anticipate and verbalize relevant details, along with the processing strategy, to promote efficient performance. A further description of the intervention procedures, based on the Template for Intervention Description and Replication guidelines, can be found in the Supplementary Material.[19]

Procedures

Prior to enrollment, a telephone screening was conducted, gathering demographics, medical history, and self-reported cognitive functioning. All subsequent study procedures were conducted remotely via Zoom. Before starting the treatment sessions, participants were required to comprehend the consent form and be capable of providing informed consent. Then, participants underwent a baseline cognitive and functional evaluation (Time 1), followed by six 75-min treatment sessions conducted twice a week. Following this initial treatment phase, participants underwent a repeated evaluation (Time 2). Participants then received additional six 60-min treatment sessions, also twice a week. The study concluded with a final evaluation to assess the intervention's impact (Time 3). Note that the occupational therapist who conducted the intervention was blinded to all evaluation results, including background information.

Table 2. Treatment description.

	Session number	Treatment activities	Active treatment ingredients
Part 1	1	Remembering words within sentences (2 tasks)	1. Task presentation 2. Self-evaluation questions regarding the task
	2	Remembering words presented with a pair (pairs associated, 2 tasks)	3. **Tasks presented in both self-generated and provided conditions** 4. **Immediate and delayed recall (15 min) of both conditions**
	3	Remembering people's names and faces (2 tasks)	5. Discussion of the effectiveness and applicability of the **self-generation**
	4	Remembering dates and location of items (2 tasks)	6. Strategy transfer: presentation of new items/ words to be remembered and **participants are asked to use the self-generation strategy to learn them.**
	5	Remembering ingredients in a recipe (2 tasks)	7. Recall of the learned items follows 8. Closing discussion 9. Self-evaluation questions 10. Task evaluations, strategy investigation 11. Journaling: what was learned and what was found helpful 12. Review of journal entry
	6	Remembering an activity of their own choice	
Part 2	7	• Finding class times and dates on a class schedule • Finding tour guide times and dates on a museum schedule	1. Task presentation 2. Self-evaluation questions regarding the task 3. **Participants are required to choose and use a strategy to perform the task**
	8	• Weekly errands • Finding brunch items on a menu	4. **Discussion of the effectiveness of the chosen strategy**
	9	• Finding restaurant business cards • Finding personal business cards	5. Strategy transfer: presentation of new items to be remembered and **participants are asked to use a strategy to learn the items**
	10	• Comparing items on two menus • Remembering names	6. Recall of the learned items follows 7. Closing discussion
	11	Shopping on a budget for a social night: • Different games • Snacks	8. Self-evaluation questions 9. Task evaluations, strategy investigation 10. Journaling: what was learned and what was found helpful
	12	• Shopping home decor on a budget • Preparing for a trip to an amusement park	11. Review of journal entry

*In bold: unique ingredients to each treatment phase.

Standard clinical and cognitive measures

We collected demographic information, including age, gender, education, and employment. Additionally, details such as MS type, duration since the onset of first symptoms, Patient-Determined Disease Steps,[20] and Instrumental ADL (IADL)[21] status were obtained from each participant.

Outcomes

Primary outcomes. Self-regulation Skills Interview (SRSI)[22] is a six-question semistructured interview designed to assess an individual's metacognitive skills and ability to employ cognitive strategies in their daily life. Each question is scored on a 10-point

Likert-type scale, with lower scores indicating greater proficiency. Sample interview questions include, "Can you tell me how you recognize that you experience [cognitive difficulty]; that is, what do you notice about yourself?" (pertaining to the Awareness subscale) and "What strategies are you currently using to cope with your [cognitive difficulty]?" (related to the Strategy Behavior subscale). The dependent variables were the SRSI Total Score (ranging from 0 to 60) as well as the Awareness (ranging from 0 to 20) and Strategy Behavior (ranging from 0 to 30) subscores. The SRSI has good interrater and test–retest reliability, particularly in individuals with acquired brain injury.[22]

Secondary outcomes. The Contextual Memory Test (CMT)[23] is designed to assess everyday memory, evaluating aspects such as awareness of memory capacity, strategy utilization, and recall of 20 picture cards grouped thematically depicting common daily items. Dependent variables include immediate and 15-min delayed recall. The CMT has three versions to avoid the practice effect, exhibiting good test–retest reliability and minimal detectable change.[24]

Everyday Memory[23] is a questionnaire included in the CMT, with participants answering 10 questions about the frequency of remembering and managing daily tasks, rated from 1 ("Never") to 5 ("Always"). A lower score indicates better everyday memory.

Strategy use was assessed by asking participants to describe the strategies they use to successfully remember everyday tasks. The assessor categorized their responses into five categories: (1) Independently generates several specific strategy examples (e.g., use list); (2) generates one specific strategy; (3) Independently generates a vague response (e.g., pay attention); (4) With general prompts, think of a strategy; and (5) Strategy is provided by the therapist. The dependent variable was the category assigned to their answer. For example, if participants reported using self-generation, their responses were classified into Category 2. This procedure is based on a validated protocol.[16]

Functional Behavior Profile (FBP)[25,26] is a self-report questionnaire that assesses individuals' functional abilities of task engagement, social interactions, and problem-solving. Item responses range from 0 to 4, with higher scores reflecting better performance, up to a maximum score of 108. The FBP has good predictive and discriminant validity.[27]

The electronic Activity Card Sort (ACS3)[28,29] consists of 100 photographed activities related to IADL, social, leisure, and fitness/exercise activities. Participants categorize those photographs into five categories: 1) 'I have never done', 2) 'I continue to do' (since illness onset), 3) 'I do less', 4) 'I have given up', or 5) I' would like to start'. The ACS3 reflects both the current level of engagement with each activity and a retained activity that reflects the percentage of activities the person currently participates in compared to preinjury involvement.[30] A higher score indicates better maintenance of preinjury activity, and the ACS demonstrates strong psychometric properties, including reliability and validity.[28,29]

Feasibility

In the current study, feasibility was assessed regarding recruitment, adherence, acceptability, and applicability. Recruitment feasibility was evaluated based on the number of participants enrolled relative to those approached. Adherence was measured by tracking session attendance and completion rates throughout the intervention. To assess acceptability and applicability, we adapted a seven-question questionnaire from a previously published feasibility questionnaire.[15,31] The questionnaire assessed treatment enjoyability, efficacy, and applicability to daily life, with responses rated on a 1–5 scale (1 = "Not true" –5 = "Very true"). It was administered at the midpoint (time 2) and post–postintervention (Time 3). Additionally, two open-ended questions were asked, inviting participants to discuss their favorite aspects of the treatment and offer suggestions for improvements. Answers to these questions were summarized qualitatively. Additionally, the Client Satisfaction Questionnaire-8 (CSQ-8)[32] consists of eight questions rated on a 1–4 Likert-type scale was used to assess participants' satisfaction with the treatment. Higher scores indicate greater acceptability and satisfaction. Finally, one author (YG) reviewed three random treatment sessions for all participants to ensure adherence to the intervention procedures. The fidelity checklist used was specifically developed to assess the multicontext treatment approach.[33]

Data analysis

Because of the small sample size, the Friedman nonparametric test was used to compare changes in pre- and postintervention outcome measures to explore clinical outcomes.[34] Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p < 0.017$. To evaluate feasibility,

we described the responses to the posttreatment patient satisfaction questionnaires. Additionally, we conducted a thematic analysis of the responses to both open-ended questions.

Results

Outcome results are presented in Table 3. Significant improvements were observed in self-awareness and strategy use as measured by the SRSI from Time 1 to Time 2 and from Time 2 to Time 3. Immediate and delayed memory scores on the CMT also improved significantly at each time point, indicating the treatment's positive impact. Everyday memory scores showed consistent improvement over time. For the FBP measures, total, task performance, social integration, and problem-solving scores significantly improved from Time 1 to Time 2 but either stabilized or slightly decreased at Time 3. The ACS scores indicated that participation was maintained throughout the treatment.

Table 4 details changes in participants' strategy use and generation. Initially, no participants independently generated multiple strategies; this increased to 1 at Time 2 and 5 at Time 3. The ability to generate specific strategies improved from 2 at Time 1 to 6 at Time 2 and 5 at Time 3. The need for general prompts and therapist-provided strategies decreased, indicating improved independent strategy generation.

Feasibility

Recruitment and adherence. We approached 14 potential participants, of whom 12 agreed to participate, resulting in an 80% acceptance rate. However, two withdrew due to prolonged hospitalization and household problems. Only one participant required assistance with the Zoom setup.

Fidelity. We sampled 25% of administered sessions (three documented treatment sessions per participant) and found 98% adherence to intervention procedures.

Acceptability and applicability. Following the intervention, CSQ-8 scores indicated high satisfaction ($M = 34.2$; $SD = 4.04$), suggesting that the virtual treatment program was well-received. Table 5 summarizes the applicability of the treatment as perceived by the participants, while Table 6 presents themes related to participant satisfaction. Participants reported increased preparedness for learning, improved memory, and enhanced confidence in applying the acquired skills to daily tasks. Participants found the treatment applicable to their daily lives, reporting improved focus, self-confidence, and reduced anxiety, along with a better understanding of their memory strategies.

Discussion

This current study evaluated the effects of a remote metacognitive strategy-based intervention on cognitive and functional outcomes in individuals with MS. The results demonstrated significant improvements in various cognitive and functional domains and the use of strategies, suggesting that the intervention had a positive impact on participants' daily lives.

Based on the active ingredients of this treatment, we predicted significant improvements in self-awareness and self-regulation, elements that were emphasized throughout all 12 sessions.[35,36] As expected, both self-awareness and self-regulation improved significantly following treatment. Furthermore, participants indicated that the treatment improved their self-confidence and helped them assess their memory abilities. As individuals became more acquainted with the treatment and memory strategies, they were better able to manage tasks through self-regulation, leading to greater success and control over their performance. These positive experiences build confidence in their abilities, reinforcing their belief in their capacity to achieve goals (self-efficacy).[35] This explanation is supported by the participants' reports that they realized that their memory was better than they thought and that the treatment improved their usage of memory strategies.

The treatment significantly improved participants' short- and long-term recall of everyday memories while reporting better strategy use, improved everyday memory and functional status. The treatment promoted not only the consolidation of the primary strategy into long-term memory but also encouraged the use of additional strategies that might better fit specific tasks or activities. Repetition and application of the strategy in various situations helped make it more readily available for daily use,[37] while the flexibility to incorporate alternative strategies further supported participants in managing different tasks effectively.[38]

We expected an improvement in participants' engagement in activity and participation, especially after the observed improvements in functional status, memory, and everyday memory. However, engagement in activity and participation, as measured by the ACS3, did not improve following this treatment. This discrepancy suggests that other factors, such as

Table 3. Outcomes of three-time points before treatment, after six treatment sessions, and following treatment ($n = 10$).

	Time 1	Time 2	Times 3	X^2 (full model)	Post hoc (p level)[$]
CMT immediate	10.1 (3.03)	12.8 (3.4)	14.3 (1.8)	14.1**	Time 1 vs 2 = .01 Time 2 vs 3 = .10 Time 1 vs. 3 = .008
CMT delayed	9.6 (3.6)	12.6 (3.8)	15 (2.5)	11.2**	Time 1 vs 2 = .08 Time 2 vs 3 = .01 Time 1 vs 3 = .007
CMT Strategy use	7.9 (4.7)	10.3 (4.4)	11.7 (2.8)	5.8*	Time 1 vs 2 = .03 Time 2 vs 3 = .39 Time 1 vs 3 = .08
Everyday memory	20.3 (9.4)	17.1 (6.4)	14.6 (3.9)	4.2	Time 1 vs 2 = .26 Time 2 vs 3 = .14 Time 1 vs 3 = .02
SRSI	42.6 (5.7)	32.7 (5.1)	27.1 (8.1)	15.1**	Time 1 vs 2 = .01 Time 2 vs 3 = .03 Time 1 vs 3 = .005
SRSI: Awareness	16.8 (2.1)	14.7 (1.7)	11.7 (3.7)	11.7**	Time 1 vs 2 = .04 Time 2 vs 3 = .03 Time 1 vs 3 = .008
SRSI: Strategy	24.6 (3.5)	18.5 (3.7)	15.1 (5.3)	15.4**	Time 1 vs 2 = .01 Time 2 vs 3 = .02 Time 1 vs 3 = .005
FBP Total	92.2 (18.5)	105 (11.8)	104.5 (11.9)	7.8*	Time 1 vs 2 = .01 Time 2 vs 3 = .62 Time 1 vs 3 = .007
FBP task performance	32.9 (6.7)	37.6 (4.9)	36.4 (5.1)	16.9**	Time 1 vs 2 = .005 Time 2 vs 3 = .006 Time 1 vs 3 = .02
FBP Social integration	33.2 (6.7)	37.4 (3.9)	37.5 (3.9)	6.5*	Time 1 vs 2 = .02 Time 2 vs 3 = .94 Time 1 vs 3 = .02
FBP problem solving	26.1 (6.2)	30 (3.9)	30.6 (3.5)	7.9*	Time 1 vs 3 = .06 Time 2 vs 3 = .40 Time 1 vs 3 = .01
ACS previous	76 (9.6)	76 (9.6)	76 (9.6)	–	–
ACS current	49.2 (9.6)	48.3 (10.9)	48.8 (12.4)	.11	Time 1 vs 2 = .62 Time 2 vs 3 = .37 Time 1 vs 3 = .95
ACS retained	65.3 (12.13)	63.8 (14.2)	64.8 (17.8)	.15	Time 1 vs 2 = .52 Time 2 vs 3 = .34 Time 1 vs 3 = .95

[$]Significance level set at $p < 0.017$.
*$p < .05$; **$p < .001$.
ACS: Activity Card Sort; CMT: Contextual Memory Test; FBP: Functional Behavior Profile; SRSI: Self-regulation Skills Interview.

environmental barriers, motor challenges, lack of motivation, and social support,[39] may influence engagement levels. Additionally, many activities listed in the ACS3 assessment are related to habits and rituals (e.g., going to church, visiting friends/family, and entertaining at home). Changing

Table 4. The number of reported strategies by participants at the three-time evaluations.

	Strategy use and generation	Time 1 number of participants	Time 2 number of participants	Time 3 number of participants
1	Independently generates several strategies to complete the task (e.g., use check list)	–	1	5
2	Independently generates 1 specific strategy	2	6	5
3	Independently generates a vague response (e.g., pay attention)	4	3	–
4	With general prompts, thinks of a strategy	1	–	–
5	Strategy is provided by the therapist	3	–	

Table 5. Participants' responses on treatment feasibility and satisfaction ($n = 10$).

		*Likert scale (1–5): number of responses				
Questions domain	Question	1	2	3	4	5
Program Satisfaction Questions	The virtual treatment program was easy to do			2	2	6
	The virtual treatment program was enjoyable.			1	1	8
Memory-Related Questions	The virtual treatment program helped me to feel more prepared to learn new information or remember items.			1		9
	The virtual memory program improved my memory			1	1	8
	The virtual memory program made me feel better about my memory.			1	1	8
Generalization to everyday	I believe the skills I learned during this training will help me function better in my daily life.				1	9
	I can easily see how I can use the skills I learned in the memory training in the future and in memory of everyday tasks			1	1	8

behaviors associated with such activities may require different types of treatment, such as one focused on habit formation.[40]

All participants completed the treatment sessions and reported high satisfaction with the intervention and found it credible. On the CSQ-8, the satisfaction questionnaire, all participants reported high satisfaction at the end of treatment. This finding is consistent with prior studies using telehealth-based, remotely delivered interventions,[15,41] in which individuals with MS reported high satisfaction with remote intervention.

To the best of our knowledge, this pilot study is among the first to evaluate a remotely delivered cognitive intervention specifically targeting everyday memory and self-awareness in persons with MS. While the use of self-generation alone has been researched in MS, the current results suggest that combining self-generation with metacognitive strategy training (i.e., the multicontext approach) delivered completely remotely may enhance efficacy, feasibility, and participant satisfaction. Including metacognitive strategy training into the self-GEN cognitive training may help transfer gains to the real world. In the current study, we found that participants continued to improve from 6 to 12 treatment sessions, demonstrating an increased ability to adapt and apply strategies effectively. The additional six intervention sessions appear to help participants express and implement a wider range of memory strategies

Table 6. Themes reported by participants following treatment.

Applicability to Daily Life and Feeling of Accomplishment:
Participants expressed that the treatment was applicable to their daily lives, leading to a sense of accomplishment.
Example:
Participant 22 "The treatment was applicable … … I'm able to recall names better …. I live in a senior place, and because I needed to remember names, the treatment helped me."
Participant 100: "I depend on a driver service and the treatment helped me to remember what I need to do when I leave the house and be ready to hop on the taxi."
P66.:"… when I write my shopping list for example. I connect visual things to audio things I need to remember."
P88. : "…. I more attuned to remember certain things following the treatment. I guess it is better now."
P. 100: " The treatment helped me develop better ways to remember. I even practiced what I learned at home."
P. 101:" The treatment helped me to assess my memory. I liked the length of the treatment. The treatment also helped in my interactions with people. I depend on a driver service, and the treatment helped me to remember what I need to do when I leave the house and e ready to hop in the taxi. I feel like I can apply some things form the treatment to my life."
Interest and engagement: Participants learned that they can remember tasks better if they are interested in them, highlighting the link between interest and memory.
Example: Participant 33 noted that the treatment showed them that liking a task can lead to better memory retention. "Show me that if I like what I do I will remember it."
P. 101:" I liked the activities and the drills. I liked the challenge,
Increased Awareness and Understanding of Memory: The treatment increased participants' awareness of their memory and taught them how to remember things better.
Example:
Participant 44: " The treatment taught me to understand how to remember things better. The treatment made me more aware, see things differently, what to pay attention to."
MS 33: "It <the treatment> helped me understand my brain"
P. 101 "The treatment helped me to assess my memory."
P.102: "and I understand how to use the strategy. I use the strategies better, awareness is improved"
Learning and Applying New Strategies: Participants learned new memory strategies and enjoyed the challenges of applying them.
Example: MS 44: "It taught me to do association with meaningful things in my life."
P.55: "I like the challenges, I liked the new tricks I learned"
P66. I learned to make connections with things I'm familiar with, …. Participant 100: "Learning how to put things together, making things more personal so I can remember better."
Participant 100: "The treatment helped me develop better ways to remember. taught me more strategies. I like the strategies. Learning how to put things together, making things more personal so I can remember better."
Improvement in Focus and Attention: The treatment helped participants focus better and stay attentive, leading to improved memory.
Example: P88.: "The treatment helped me become focused. It taught me not to lose attention, to stay focused. I more attuned to remember certain things following the treatment. I guess it is better now."
Creativity and Reduced Anxiety: Participants reported increased creativity and reduced anxiety as a result of the treatment.
ExampleP99.: "It taught me to be more creative, think outside the box. It reduced my anxiety"
Participant 100: "It reduced my anxiety."
Boost in Self-Confidence and Memory Assessment: The treatment improved participants' self-confidence and helped them assess their memory abilities.
Example: Participants 22: "… feeling of accomplishment. I could see the progress from beginning to end …"

(continued)

Table 6. Continued.

Applicability to Daily Life and Feeling of Accomplishment:
P.100: "made me feel better about my memory, confirmed what I did,."
P. 88: "I guess it <my memory> is better now."
P. 101:" I liked the challenge, to see what I can remember and how my memory gets better. I liked to find out how I did it helped me with my self-confidence."
Realization of Improved Memory and Better Strategy Usage: Participants realized that their memory was better than they thought and improved their usage of memory strategies.
Example: Participant 102 mentioned that their favorite part was realizing that their memory was better than they thought and using the strategies more effectively.
Participant 100: "I saw improvement from week to week and I understand how to use the strategy."
Participant 102: "I even practiced what I learned at home."

across different situations. Thus, results suggest that including this phase may improve metacognition and strategy use.

Study limitations

This study had only 10 participants and lacked a control group or participants' blinding, limiting conclusions about clinical efficacy. The findings on acceptability and feasibility should be considered preliminary. A follow-up pilot randomized controlled trial is necessary to robustly evaluate feasibility and satisfaction and to provide initial evidence of clinical efficacy. Our study cannot determine if a combined self-GEN and Multicontext intervention leads to greater clinical gains and transfer to everyday life compared to each treatment component alone. Additionally, we did not assess potential contributing factors such as mood or sleep quality, which influence cognitive function. Future studies should consider including these assessments at baseline and following the intervention to better understand their impact on intervention outcomes. Lastly, some of the outcome measures were assessed using a self-reported outcome. Self-reported cognitive functioning can be influenced by affect and limited self-awareness. While valuable, these reports should be interpreted cautiously.

In conclusion, the findings of the present study suggest preliminary proof-of-concept data on the positive impact of a virtual metacognitive strategy-based intervention on cognitive and functional outcomes in individuals with MS. This comprehensive approach facilitated learning, memory, self-awareness, and self-regulation among participants, leading to increased self-confidence and improved memory abilities. Feasibility and efficacy should be further evaluated in larger trials using factorial design to compare the treatment ingredients and including control groups with assessors blind to group assignment.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: JT receives royalties from a book on the Multicontext Approach cited in the reference list and reports financial interests in MC CogRehab Resources, LLC., a company that produces functional cognitive treatment activities, some of which were used within this research project.

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