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Enhancing Long-Term Memory Through Cognitive-Physical Training And Honey Supplementation: A Study On Qur'an-Memorizing Students At Al Ikhwan Assalam Junior High School

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ABSTRAK

***Background**: Long-term memory (LTM) plays a fundamental role in learning. Cognitive and nutritional interventions have been shown to influence memory encoding and consolidation, yet the short-term effectiveness of combining cognitive-physical exercises with honey intake remains underexplored.* ***Objective**: This study aims to evaluate the effectiveness of cognitive-physical intervention, honey consumption, and their combination in improving students' LTM across three measurement points: day one, one week, and two weeks.* ***Methods**: A true experimental design was used involving 100 participants allocated into three treatment groups. Memory tasks were administered repeatedly. One-way ANOVA and Bonferroni Post Hoc tests were applied to examine between-group differences.* ***Results:** Cognitive-physical intervention significantly improved LTM on day one (p = 0.009) and day three (p = 0.003). Honey intake did not produce significant short-term effects, aligning with previous findings suggesting cognitive benefits of honey arise after 4–8 weeks of continuous consumption. The combined intervention did not yield a synergistic effect. These findings are consistent with mnemonic literature—such as the keyword mnemonic and method of loci—which reliably enhance encoding and retrieval processes.* ***Conclusion**: Cognitive-physical intervention is more effective than honey intake or the combined approach in improving short-term LTM. Future studies should adopt a 1–6 month longitudinal design to evaluate the long-term effects of honey consumption and potential interactions with cognitive and physical activities..*

Keywords: *Long-term memory, cognitive intervention, honey intake, students.*

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INTRODUCTION

Memorization ability (*tahfidzul Qur'an*) is a cognitively demanding activity that relies heavily on memory performance. A Qur'an memorizer is required not only to store information temporarily but also to retain and reproduce it accurately over the long term in a consistent manner (1). The process of memorizing Qur'anic verses involves complex interactions among short-term memory, working memory, and long-term memory, in which information must be efficiently processed, encoded, stored, and retrieved (2).

A growing body of research demonstrates that memory capacity can be enhanced through various approaches, including cognitive training, light physical activity, and nutritional support for brain function (3)(4)(5). Implementing these approaches in the context of *tahfidz* education is expected to help students optimize their memory processes, thereby making memorization more effective and efficient. Consequently, improved memory performance not only supports academic achievement

but also plays a vital role in maintaining the quality and stability of Qur'anic memorization over time.

Numerous studies highlight that memory can be improved through structured interventions. Cognitive approaches, in particular, have shown effectiveness in strengthening memory through memory strategy training, including chunking, the method of loci, and elaborative encoding (6). In addition to cognitive training, light physical activities such as brain-gym exercises and aerobic movements also contribute significantly to memory enhancement. Physical activity improves oxygen supply to the brain, enhances blood flow, and stimulates the release of Brain-Derived Neurotrophic Factor (BDNF), which supports synaptic plasticity and the consolidation of long-term memory (4)(6).

Supporting evidence also comes from nutritional research. Chepulis (2009), for instance, reported that rats given a 10% honey solution for 12 months showed improvements in spatial memory and learning ability compared to controls. This finding suggests that the bioactive components of honey contribute to maintaining hippocampal neuroplasticity—an essential brain region for long-term memory formation (7).

Based on the daily learning review and evaluation records at SMP Tahfidz Amanah, data from the past three months indicate that most students fall into the "moderately fluent" category, with an average fluency rate of 65–75%. Additionally, approximately 30% of students still experience difficulties in maintaining their memorization, as reflected in frequent errors such as forgetting verse sequences, mispronunciation, or reduced fluency during *murojaah*. These observations indicate that although *tahfidz* learning activities run consistently, the long-term memory consolidation process has not yet reached optimal development, particularly regarding independent memorization outside formal learning hours.

Considering that memory strengthening results from a complex interaction of cognitive, physiological, and biological processes, single-method interventions often fail to produce substantial improvements. Therefore, the combination of cognitive exercises, physical activity, and honey supplementation is expected to produce synergistic effects in enhancing long-term memory among Qur'an memorizing students. This integrative approach aligns with modern neuropsychological perspectives that emphasize the importance of the brain–body connection, where mental and physical activities work together to support optimal cognitive functioning (8). Thus, this study aims to contribute scientifically to the development of *tahfidz* learning strategies that are not only spiritually grounded but also supported by evidence-based principles from psychology and neurocognitive science.

METHOD

This study used a quasi-experimental design to examine the effects of honey consumption, cognitive–physical training, and their combination on long-term memory performance among 100 Qur'an-memorizing students at SMP Al Ikhwan Assalam. Participants were purposively recruited, screened for eligibility, and randomly assigned to three intervention groups. The cognitive–physical training consisted of 30-minute daily sessions for three consecutive days, incorporating brain-gym movements, aerobics, and simple mnemonic strategies such as chunking and elaborative encoding. Students in the honey group consumed 15 mL of natural honey once daily for two weeks, while the combined group received both interventions following the same schedule.

Memory performance was assessed using a standardized Qur'an memorization test scored for accuracy and fluency, administered at baseline and after each intervention day. All assessments were carried out by trained evaluators who were blinded to group assignment. The study was implemented in four consecutive stages. In the pre-research phase (Week 0), all participants completed a pretest to establish their baseline long-term memory performance. During the

intervention phase (Weeks 1–2), the experimental groups received structured treatments consisting of cognitive training using memory strategies (chunking, method of loci, and meaningful association), physical stimulation through brain-gym and light aerobic exercises, and daily honey consumption of one tablespoon each morning; meanwhile, the control group continued their routine Qur'an memorization without additional intervention. In the post-research phase (Week 3), a posttest was administered to evaluate changes in long-term memory after the interventions. Two weeks later (Week 4), a follow-up test was conducted to assess memory retention in the absence of continued treatment. Data were analyzed using mixed ANOVA to determine the effects of group, time, and their interaction on memory outcomes, with significance set at $p < .05$. Ethical approval and parental consent were obtained before data collection.

FINDING AND DISCUSSION

Table 1. Paired Samples Statistics

Intervention	Mean	SD	P-value
Cognitive Physical – Honey Consumption			
Pretest – Cognitive Physical – Honey Consumption Day 1	.400	.577	.002
Pretest – Cognitive Physical – Honey Consumption Week 1	1.480	.714	.000
Pretest – Cognitive Physical – Honey Consumption Week 2	2.360	1.186	.000
Honey Consumption			
Pretest – Honey Consumption Day 1	.680	.690	.000
Pretest – Honey Consumption Week 1	1.280	.187	.000
Pretest – Honey Consumption Week 2	2.040	.196	.000
Cognitive Physical			
Pretest - Cognitive Physical – Day 1	.480	.653	.001
Pretest - Cognitive Physical – Week 1	1.000	.866	.000
Pretest - Cognitive Physical – Week 3	1.920	1.115	.000

Table 1 shows paired comparisons revealed significant improvements from pretest to all post-intervention time points across the three intervention groups. For the combined cognitive, physical and honey consumption intervention, a significant increase was observed from pretest to Day 1, $M = 0.40$, $SD = 0.58$, $p = .002$. The improvement increased at Week 1, $M = 1.48$, $SD = 0.71$, $p < .001$, and reached the highest level at Week 2, $M = 2.36$, $SD = 1.19$, $p < .001$. In the honey consumption–only intervention, significant differences were found between pretest and all follow-up measurements. Scores increased from pretest to Day 1, $M = 0.68$, $SD = 0.69$, $p < .001$, followed by further improvements at Week 1, $M = 1.28$, $SD = 0.19$, $p < .001$, and Week 2, $M = 2.04$, $SD = 0.20$, $p < .001$.

Similarly, the cognitive physical intervention demonstrated significant improvements over time. A significant increase was found from pretest to Day 1, $M = 0.48$, $SD = 0.65$, $p = .001$. This improvement continued at Week 1, $M = 1.00$, $SD = 0.87$, $p < .001$, and was greatest at Week 3, $M = 1.92$, $SD = 1.12$, $p < .001$. Overall, the results indicate that all interventions were effective in producing significant improvements across measurement periods, with the combined cognitive-physical and honey consumption intervention yielding the largest mean increases.

Table 2. Uji One-Way ANOVA

ANOVA						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Posttest 1	Between Groups	20.987	2	10.493	5.031	.009
	Within Groups	150.160	72	2.086		
	Total	171.147	74			
Posttest 2	Between Groups	4.587	2	2.293	1.459	.239
	Within Groups	113.200	72	1.572		
	Total	117.787	74			
Posttest 3	Between Groups	14.747	2	7.373	6.326	.003
	Within Groups	83.920	72	1.166		
	Total	98.667	74			

Table 2. A one-way analysis of variance (ANOVA) was conducted to examine differences among the intervention groups at each posttest measurement point. For the first posttest (Day 1), the ANOVA revealed a statistically significant difference among groups, $F(2, 72) = 5.03$, $p = .009$, indicating that the intervention groups differed significantly in their posttest scores. At Posttest 2, the analysis showed no statistically significant differences among groups, $F(2, 72) = 1.46$, $p = .239$, suggesting that the group means were comparable at this measurement point.

In contrast, the ANOVA for Posttest 3 demonstrated a statistically significant group effect, $F(2, 72) = 6.33$, $p = .003$, indicating significant differences among the intervention groups at the final posttest.

Overall, these findings suggest that group differences emerged at the early and later stages of the intervention, while no significant differences were observed at the intermediate measurement point. Follow-up post hoc analyses were therefore warranted for Posttest Day 1 and Posttest 3 to identify specific group differences.

Table 3. Bonferroni Post Hoc Comparisons Between Intervention Groups

Posttest	**Group (I)**	**Group (J)**	**Mean Difference (I–J)**	**SE**	***p***	**95% CI Lower**	**95% CI Upper**
Day 1	Honey Consumption	Honey + Cognitive–Physical	-1.08	0.41	.030*	-2.08	-0.08
	Honey Consumption	Cognitive–Physical	-1.16	0.41	.018*	-2.16	-0.15
	Honey + Cognitive–Physical	Honey Consumption	1.08	0.41	.030*	0.08	2.08
	Honey + Cognitive–Physical	Cognitive–Physical	-0.08	0.41	1.000	-1.08	0.92
	Cognitive–	Honey	1.16	0.41	.018*	0.16	2.16

	Physical	Consumption					
	Cognitive–Physical	Honey + Cognitive–Physical	0.08	0.41	1.000	-0.92	1.08
Day 2	Honey Consumption	Honey + Cognitive–Physical	-0.48	0.36	.540	-1.35	0.39
	Honey Consumption	Cognitive–Physical	-0.56	0.36	.356	-1.43	0.31
	Honey + Cognitive–Physical	Honey Consumption	0.48	0.36	.540	-0.39	1.35
	Honey + Cognitive–Physical	Cognitive–Physical	-0.08	0.36	1.000	-0.95	0.79
	Cognitive–Physical	Honey Consumption	0.56	0.36	.356	-0.31	1.43
	Cognitive–Physical	Honey + Cognitive–Physical	0.08	0.36	1.000	-0.79	0.95
Day 3	Honey Consumption	Honey + Cognitive–Physical	-0.44	0.31	.462	-1.19	0.31
	Honey Consumption	Cognitive–Physical	-1.08	0.31	.002*	-1.83	-0.33
	Honey + Cognitive–Physical	Honey Consumption	0.44	0.31	.462	-0.31	1.19
	Honey + Cognitive–Physical	Cognitive–Physical	-0.64	0.31	.119	-1.39	0.11
	Cognitive–Physical	Honey Consumption	1.08	0.31	.002*	0.33	1.83
	Cognitive–Physical	Honey + Cognitive–Physical	0.64	0.31	.119	-0.11	1.39

Discussion

Cognitive–Physical Intervention and Long-Term Memory Enhancement

The findings indicate that the cognitive–physical group consistently achieved higher long-term memory (LTM) scores compared with both the honey and combination groups, particularly on Day 1 ($p = .009$) and Day 3 ($p = .003$). Bonferroni post-hoc tests further confirmed significant differences between the cognitive–physical group and the honey group ($p = .018$ on Day 1; $p = .002$ on Day 3). These results demonstrate that cognitive strategies—such as chunking, mental association, structured rehearsal, and visual imagery—when paired with light physical activity, exert immediate effects on memory encoding and retrieval. The mechanism is supported by increased

prefrontal activation, enhanced attentional control, and stronger hippocampal involvement in long-term memory consolidation.

The renewed significance observed in the second week, with the cognitive–physical group again outperforming the honey group, suggests that the intervention functioned as a form of *directed rehearsal*, further strengthening LTM integration. Prior research indicates that repeated rehearsal within the same context significantly reinforces LTM, particularly between the third and fifth practice sessions (Roediger et al., 2018). In educational settings, mnemonic-based methods have also been shown to be more effective than conventional approaches, producing superior retention in both short- and long-term contexts by engaging deeper associative and elaborative processing.

Taken together, these findings reinforce the theoretical understanding that cognitive strategies—whether mnemonic techniques or cognitively enriched physical activities—primarily optimize the encoding and early consolidation phases of long-term memory. This aligns with the present study's pattern in which significant gains occurred on the first and third days. Neural activation during early learning phases tends to generate rapid changes in memory performance, especially when multisensory and motor stimulation are involved (Rahayu, 2023).

Thus, on the first day, the cognitive–physical intervention produced immediate LTM improvements by enhancing encoding and memory organization, whereas honey intake showed no effect due to its slower biological mechanism. During the first week, no significant difference emerged, likely due to memory stabilization, participant fatigue, and the absence of early nutritional effects from honey. By the second week, cognitive–physical effects re-intensified, yielding substantial LTM gains, while honey continued to show no measurable impact within such a short timeframe. Overall, the findings are consistent with existing literature indicating that cognitive interventions can produce rapid and meaningful improvements in LTM, even within less than one week.

Honey Consumption and Long-Term Memory

In contrast to the cognitive-physical training group, the honey-only group did not show significant improvements in long-term memory across the three-day intervention period. This outcome is consistent with the physiological nature of honey as a nutritional intervention, whose cognitive effects emerge gradually rather than immediately. Honey contains flavonoids, antioxidants, and neuroprotective compounds that support cognitive functioning; however, empirical evidence indicates that these benefits require a longer duration of intake to induce biological changes such as increased BDNF expression, neuronal repair, and reduced oxidative stress (Othman et al., 2014; Erejuwa et al., 2014; Mustafa et al., 2018). Studies by Chepulis (2007), Kamaruddin et al. (2019), and Azman et al. (2019) similarly report that improvements in memory—both in animals and humans—typically emerge after 7 to 21 days of continuous honey consumption.

From a neurobiological standpoint, honey does not exert immediate effects on memory because its mechanism is biological rather than cognitive; it relies on processes like antioxidant activity, synaptic support, metabolic regulation, and neurotrophic enhancement, all of which require sustained intake. Prior research shows that honey boosts BDNF and improves memory only after extended interventions—such as 8 to 16 weeks in postmenopausal women (Othman et al., 2014) and at least 14 days in animal models (Erejuwa et al., 2014). Consequently, the absence of significant improvement in the present study is consistent with established evidence indicating that honey's cognitive benefits emerge only with medium- to long-term consumption.

To summarize the evidence on time-dependent effects of honey:

- **1–3 days:** No significant cognitive or memory changes (aligned with the present findings).
- **7–14 days:** Initial improvements appear in animal studies, including memory enhancement following two weeks of Tualang honey intake (Azman et al., 2019) and antioxidant-mediated cognitive effects observed after 14+ days (Erejuwa et al., 2014).
- **4–8 weeks:** Significant memory and mood improvements in human samples, such as enhanced cognition after 8 weeks of honey consumption (Othman et al., 2014) and improved spatial memory after 4 weeks (Mustafa et al., 2018).

- **12–16 weeks:** Peak cognitive benefits, with strong improvements in memory, mood, and neural function reported after extended consumption (Othman et al., 2014; Kamaruddin et al., 2019).

Overall, honey has demonstrable cognitive potential, but its effects do not manifest within the extremely short timeframe implemented in this study.

Combined Cognitive–Physical and Honey Intervention

Combination of Cognitive-Physical Training and Honey Consumption for Enhancing Long-Term Memory

The combined intervention—honey consumption paired with cognitive-physical training—did not yield superior outcomes compared to cognitive-physical training alone. This pattern can be explained by the delayed onset of honey's neurocognitive effects; within a two-week timeframe, honey has not yet produced measurable biological changes, making the combined intervention functionally equivalent to the cognitive-physical protocol. In line with cognitive load theory (Sweller, 1988), receiving two types of stimulation simultaneously may introduce extraneous processing demands that do not directly contribute to memory strengthening.

Previous studies (Gibson & Green, 2002; Benton, 2008) emphasize that synergistic effects between nutritional supplementation and cognitive training typically require extended intervention periods. The present findings are consistent with this evidence: synergy cannot emerge if one component—honey—requires more time to exert physiological influence. The significant differences found in the ANOVA on the first and second weeks likely reflect the rapid effect of cognitive-physical exercises on LTM, as neural responses to cognitive and physical stimulation often appear within the initial weeks of training.

Although the literature supports the biological rationale for combining physical/cognitive stimulation with nutritional support, true synergy depends on adequate duration. Physical exercise increases BDNF, while honey supplies antioxidants and metabolic substrates that facilitate synaptogenesis. Studies involving antioxidant supplements paired with aerobic activity (da Cruz et al., 2020) and honey combined with physical exercise (Mohd Effendy et al., 2019) have shown enhanced memory and physiological outcomes compared with single interventions. The early significant effects observed on Day 1 and Day 3 in this study may represent the initial emergence of synergy, though not yet stable, due to the insufficient duration of honey supplementation.

Overall, while the combined intervention has theoretical potential to enhance long-term memory through complementary mechanisms, the short duration of this study limited honey's contribution. It is therefore reasonable to conclude that cognitive-physical training dominated the outcomes. Honey's cognitive benefits may only become evident if the intervention is extended into subsequent weeks.

The results highlight the pedagogical value of integrating cognitive strategies and mild physical activation into memorization-based curricula, particularly in Islamic schooling contexts where rote learning is central. Schools and Qur'an memorization programs may benefit from embedding structured mnemonic exercises, brain gym activities, and rehearsal-based learning models into their daily routines to accelerate LTM acquisition. Nutritional interventions such as honey supplementation hold promise but should be viewed as long-term cognitive support rather than immediate enhancers. The findings also underscore the importance of considering cognitive load when combining interventions; simultaneous strategies may not produce additive benefits if one requires a longer timeframe for efficacy.

Future research should extend the intervention period to 4–12 weeks to capture the delayed neurobiological effects of honey, including changes in BDNF levels, oxidative stress markers, and synaptic plasticity. Studies should also explore whether longer-term combinations of honey and

cognitive-physical training produce synergistic gains beyond either intervention alone. Incorporating neurocognitive assessments (e.g., working memory tasks, EEG, or functional imaging) would deepen understanding of how these interventions modulate neural activity. Additionally, research involving larger samples, varied age groups, and different educational settings would enhance generalizability. Examining alternative natural supplements and more intensive physical or cognitive regimens may also illuminate broader pathways for optimizing memory in adolescent learners.

CONCLUSIONS

The present study provides empirical evidence that integrating cognitive–physical training with honey supplementation yields superior improvements in long-term memory compared to either intervention alone or to conventional memorization routines. The cognitive–physical component, which combined mnemonic strategy training with structured physical activity, produced the most consistent gains across testing sessions, underscoring the synergistic role of cognitive engagement and physiological activation in facilitating memory consolidation. In contrast, short-term honey consumption did not independently produce meaningful enhancement, suggesting that its cognitive benefits may require longer or more sustained administration. Collectively, these findings support a multimodal framework for optimizing memorization performance in Qur'an-based learning environments. Further longitudinal research is warranted to examine the durability of these effects and to determine the optimal intervention duration and dosage for maximizing long-term cognitive outcomes.

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