Neural Mechanism-Informed Analysis of Fitness Tracking Data for Memory Performance Associations

(Image generated by MidJourney AI)

Extending Manning et al. (2022)'s findings on activity-memory associations, this study engineers biometric features based on BDNF, cerebral blood flow, and cholinergic system literature to identify exercise patterns that predict memory performance and help establish foundations for cognitive assessment through wearable devices.

Abstract

Wearable fitness trackers generate detailed physiological data that may reveal exercise patterns that approximate cognitive performance through specific neural mechanisms. This study engineered features based on brain-derived neurotrophic factor (BDNF), cerebral blood flow, and cholinergic system literature to identify whether mechanism-optimized exercise patterns predict memory performance more effectively than conventional fitness metrics. Using Principal Component Analysis on the Manning et al. (2022) dataset of 113 participants with year-long Fitbit data and memory task performance, the analysis revealed that neural mechanism proxy features formed coherent behavioral patterns, with PC1 capturing 40.4% of variance and showing that theoretical BDNF and cerebral blood flow optimization features clustered together. Also, clustering analysis revealed participant phenotypes such as 13.3% of participants displaying high neural mechanism proxy optimization and superior memory performance. However, direct associations between mechanism optimization and memory outcomes remained modest. This suggests that individual cognitive responses to exercise involve more personalized patterns that may require supervised learning approaches for practical prediction applications.

Background and Literature Review

Wearable fitness trackers are currently used for applications like physical health and wellness, sleep, and athletics, displaying strong adoptability, results, and potential for future expanded applications (1-3). The fine-grained physiological and behavioral sensor data obtained from these wearable fitness trackers, known as "digital biomarkers" (4), are exhibiting promising implications for cognitive performance and health, as research continues to find links between physical activity and improved cognition (17, 18). These cognitive benefits are task-specific and highly individualized; the same level of physical activity could affect two individuals in different ways (6, 35).

Despite this interpersonal variability, various cognitive benefits of physical activity appear to follow from enhanced cardiorespiratory (i.e., aerobic) fitness (20, 24) due to its neural effects (5-7, 11) and improved brain structure (13, 14). Research has shown that aerobic fitness has led to substantially reduced brain volume loss as a result of aging (26), and aerobically higher-fit children displayed improved cognitive performance and executive control when compared with lower-fit children (7). However, a meta-regression analysis shows that individual studies displaying changes in aerobic fitness do not consistently demonstrate improved cognitive performance. Still, it's possible that aerobic fitness mediates the physical activity-cognition relationship through mechanisms more closely tied to cognitive performance (6). Therefore, in order to address these inconsistencies, any discussion of aerobic fitness with regard to cognition would have to delve into the underlying neural mechanisms which result from chronic or acute aerobic physical activity, and more directly associate with cognitive improvements. Aerobic activity is more of a gross measurement, prone to high variability in effects and execution, but neural mechanisms introduce more specificity which can hypothetically lead to stronger correlations between physical activity and cognition. This project will delineate the neural mechanisms surrounding neurotrophins, cerebral blood flow, and the cholinergic system in the context of cognitive and memory performance.

Neurotrophins (BDNF): Molecules like brain-derived neurotrophic factor (BDNF), insulin-like growth factor 1, and vascular endothelial growth factor help facilitate downstream effects of aerobic fitness on cognition. These neurotrophins show increased presence with exercise and benefit synaptic plasticity, especially in the hippocampus, which ultimately benefits cognitive domains (12). In particular, BDNF plays a key role in plastic changes related to learning and memory (32). BDNF levels rise acutely following exercise, with the magnitude of increase more pronounced in individuals with chronic exercise patterns (15-17). These acute increases return to baseline within hours, but individuals with regular exercise develop chronically elevated baseline BDNF levels, which may underlie long-term cognitive benefits (5, 40). Other studies back up the role of consistent aerobic exercise in BDNF's proliferation, suggesting that chronic physical activity on a weekly or monthly basis positively influences cognition (17).

Cerebral Blood Flow (CBF): Another neural factor associated with aerobic fitness is cerebral blood flow (CBF). CBF is known to affect cerebral metabolism (44), and is thus involved in cognitive function. A link has been proposed between physical activity, CBF, and cognition, and various studies have backed this up. For instance, a cross-sectional study of 307 participants revealed that healthy men aged 18–79 with better aerobic fitness had 17% higher cerebral blood flow compared to their sedentary counterparts (41). Another study gave participants a 12-week aerobic and anaerobic fitness intervention, and found "a significant association between CBF and executive function, suggesting that CBF may represent a potential mechanism through which exercise enhances executive function" (27), likely occurring through increased blood flow to frontal regions of the brain (7, 43).

Cholinergic System: The cholinergic system, which uses acetylcholine (ACh) as its primary neurotransmitter, plays a crucial role in cognitive processes including attention, learning, and memory functions, particularly through its activity in the hippocampus and cortex (28). When exercise is initiated, brain acetylcholine levels increase primarily in these regions, with ACh causing the generation of hippocampal theta waves that help augment memory production (38). Long-term moderate-intensity aerobic exercise has been shown to support cognitive performance and prevent age-dependent loss of cholinergic fiber innervation in animal studies (28). Additionally, acetylcholine acts as a mediator in the regulation of BDNF in the hippocampus, suggesting the cholinergic system's important role in exercise-induced neuroplasticity (25).

Cognition is multifaceted, and these neural mechanisms don't fully comprise the aerobic fitness-cognition link. For example, gamma amino butyric acid, serotonin, and noradrenaline all mediate BDNF regulation in the hippocampus (25). Despite the topic's inherent complexity, BDNF, CBF, and the cholinergic system were chosen as primary factors to analyze in the fitness-cognition link because:

A. They are possible mechanisms through which physical activity becomes associated with improved cognition, and there is strong research backing for these links (5, 27, 28).
B. I hypothesize that behavioral and physiological patterns associated with these factors can be detected through wearable fitness trackers by proxy (see Experiment section).

Moreover, the BDNF, CBF, and cholinergic system mechanisms have demonstrated associations with each other, which suggests they act in unison under aerobically active situations to result in improved cognition. For example, giving Alzheimer's disease patients acetylcholine-enhancing treatment led to restored BDNF expression (29). Research also suggests that exercise-induced increases in CBF and oxidative stress partially explain BDNF release through separate mechanisms, which in turn explains improved cognitive performance (30).

These mechanisms operate on complementary timescales: acute BDNF responses during exercise sessions, progressive CBF adaptations over weeks, and chronic cholinergic optimization through sustained activity patterns. Wearable devices can indirectly capture the activity patterns that may relate to these overlapping processes, and prospectively lead to more robust memory associations based on digital biomarkers. Of course, measuring digital biomarker patterns isn't the same as direct real-time analysis of an individual's neural mechanisms, but the latter is impractical, and the former may offer a modality for leveraging wearable fitness tracking data as a proxy for cognitive insights. Specific wearable patterns hypothesized to reflect each mechanism will be detailed in the Methods and Experiment section, including temporal characteristics and physiological signatures. These activity-mechanism associations are grounded in neuroscience and physiology literature demonstrating specific patterns of neural response to different exercise characteristics.

Memory performance—particularly with episodic, working, and spatial memory (21, 22, 33, 34)—is one of the key cognitive domains displaying associations with aerobic fitness and physical activity, and these aforementioned neural mechanisms may play a role in determining that link. Research has also shown that even a short-term one-week physical fitness intervention can increase cerebral blood flow in the hippocampus (23), the brain region most associated with memory. Additionally, BDNF presence is known to facilitate neuronal long-term potentiation, possibly connecting physical activity to stronger memory performance (31). This was demonstrated in a year-long study, where aerobic exercise increased CBF and became associated with improved memory (42). BDNF-mediated neuroplasticity is also proposed as one of the underlying mechanisms for memory consolidation, as evidenced by memory performance in animal models and BDNF expression in human brain regions associated with memory, like the hippocampus and amygdala (32). Finally, research has drawn an "association between the exercise-related improvement of spatial memory and the improvement of septohippocampal cholinergic system" (34). Emerging research is increasingly linking memory performance to longitudinal, long-term activity patterns, such as the "Fitness tracking reveals task-specific associations between memory, mental health, and physical activity" paper by Manning et al. (2022).

The Manning et al. (2022) paper mirrored these associations between fitness-related activity and memory performance, displaying a positive correlation between: recent "fat burn" cardiovascular activity and recall memory performance, recent high-intensity activity and spatial memory, and a negative correlation between recent sedentary activity and spatial memory (35). This paper's longitudinal dataset containing one year of participant digital biomarkers with associated memory performance presents a fruitful opportunity to explore the aerobic fitness-cognition hypothesis. The neural mechanisms associated with the cognitive benefits of aerobic fitness could be connected to this memory performance dataset, thus working towards a cognitive performance profile based on wearable fitness tracking.

Of course, one's cognitive performance cannot be comprehensively distilled from neural mechanism-related aerobic fitness markers—a full assessment would require factoring in neuroimaging (10) and demographics like age (10), sex (19, 20), medical conditions (8), and genetics (9). Children, for example, display more generalized cognitive benefits as a result of physical fitness interventions due to their developmental stage (7).

Rather than trying to paint a complete picture, the overarching goal of this project is to set foundations for a unified model that combines neural mechanism-informed features to predict and assess cognitive performance through wearable fitness trackers. A more intricate, personalized platform can be constructed from here, incorporating other factors like age, genetics, and mental conditions (see Discussion section). Although standardized cognitive assessments already exist—such as the Cambridge Neuropsychological Test Automated Battery or Montreal Cognitive Assessment—these platforms aren't practical to use on a regular basis for people who are simply looking for insights to improve their cognitive performance and health.

Finally, research has established that "enriched environments" have neural consequences that improve learning and memory and enhance neurogenesis (37). Other research reviewing the effectiveness of aerobic fitness for improving cognition has suggested that more cognitively-demanding exercise—such as that involving learning processes, executive control, and information processing speed—could result in higher cognitive impact (6). This factor can also be considered alongside the neural mechanistic approach, to explore whether it reveals stronger memory associations in participants. So in addition to aerobic fitness patterns that relate to neural mechanisms, the exercise's level of cognitive enrichment is another important component, and can prospectively be measured by proxy digital biomarkers.

While individual responses to exercise vary significantly, population-level patterns may still emerge for the activity characteristics that generally promote these neural mechanisms. This project will examine whether such patterns can be identified from wearable data. This project **hypothesizes** that aerobic activity patterns theoretically associated with enhanced neural mechanism function—specifically patterns that may enhance BDNF circulation, cerebral blood flow, cognitive enrichment, and cholinergic system activity—will more strongly associate with memory performance. While direct neural mechanism measurement is impractical, this approach will test whether activity patterns theoretically associated with mechanism optimization show stronger correlations with memory performance compared to conventional metrics. Overall, these findings could provide enhanced foundations for cognitive assessment through wearable devices.

Methods

In this project, I ran Principal Component Analysis (PCA), feature engineering, and dimensionality reduction techniques to examine the Manning et al. (2022) dataset containing participants' fitness and activity habits, mental health measures, and performance on a set of memory tasks (35).

Two complementary PCA analyses were conducted to evaluate different approaches to biometric feature engineering. The first analysis employed 15 theory-driven neural mechanism features based on BDNF, cerebral blood flow, cholinergic system, and cognitive enrichment literature. The second analysis incorporated 18 features combining the original neural mechanism variables with some demographic variables (age, sex) and basic biometric measures (activity means and variability coefficients) to provide additional behavioral context.

Data preprocessing included median imputation for missing values, standardization of all features, and removal of entirely missing variables (stress_level). K-means clustering was applied to principal component spaces to identify participant phenotypes, and Random Forest classification was used to assess memory prediction accuracy using the first five principal components. Multiple testing corrections were applied using Bonferroni adjustment to control for false discovery rates in comparative analyses.

Experiment

This analysis moves beyond conventional fitness metrics to test whether exercise patterns that theoretically optimize specific neural mechanisms show stronger associations with memory performance than gross measures of aerobic activity. Rather than treating physical activity as a monolithic variable, features were engineered based on literature demonstrating distinct physiological pathways through which exercise influences cognition: BDNF elevation through chronic training consistency (22), cerebral blood flow optimization via specific intensity windows (42), cholinergic system preservation through moderate-intensity exercise patterns (28), and cognitive enrichment through activity complexity (6).

Each feature represents an inferential proxy for underlying neural processes, grounded in research showing that sustained moderate-intensity exercise elevates baseline BDNF levels (22), that cerebral blood flow peaks at 60-70% VO2max before declining due to hyperventilation effects (27), and that age-dependent cholinergic benefits emerge primarily from consistent moderate activity rather than high-intensity training (28). Using the Manning et al. (2022) dataset of 113 participants with year-long Fitbit data and memory task performance (35), these mechanism-informed features were extracted from individual participant timeseries and analyzed via PCA to identify whether neural mechanism-based activity patterns predict or associate with cognitive outcomes more effectively than traditional step counts or total exercise minutes.

Note 1: this project will proceed with the definition of physical activity as body movements that result in "energy expenditure," measured by calories. On the other hand, exercise is a subset of physical activity that follows a regular plan and structure, the objective of which is "the improvement or maintenance of physical fitness" (46). The following details will adhere to these definitions.

Note 2: "CV" refers to the coefficient of variation.

BDNF Features:

Theoretical basis: BDNF requires structured exercise consistency rather than total energy expenditure. "Regular exercise intensifies the magnitude of these effects with increased BDNF responsivity" (15) and "sex significantly moderated the effect of exercise on BDNF levels such that males saw larger increases in BDNF following physical activity" (15). Also, "The brain-derived neurotrophic factor (BDNF) mediates the plasticity-related changes that associate with memory processing during sleep," thus emphasizing the role of regular and consistent sleep (47).

- Training consistency CV (lower = more consistent weekly exercise sessions)
- Weeks meeting 3×/week threshold
- Sex-adjusted consistency (1.2× for males, 0.8× for females)

- Optimal session frequency (≥30 min at ≥60% VO2max)
- Duration consistency CV (lower = more regular sleep schedule)
- Optimal duration adherence (% nights within 7-9 hour range)

Cerebral Blood Flow (CBF) Features:

Theoretical basis: CBF seems to peak at specific intensities regardless of calories burned. "CBF velocity in the MCA increasing linearly with exercise intensity until approximately 60–70% of maximal VO2 max" (27) and "12-week aerobic exercise training program significantly increased MCAv" (27).

- Daily optimization score (fat burn 1.0×, cardio 0.3×, peak -0.1×)
- Intensity consistency CV
- Structural adaptation eligibility (≥12 weeks required)
- Sustained aerobic score (% weeks ≥150 min CBF-optimizing exercise)

Cholinergic System Features:

Theoretical basis: Acetylcholine increases with exercise initiation and benefits from moderate intensity. "When exercise is initiated, the brain acetylcholine levels increase, primarily in the hippocampus and cortex" (25) and "long-term moderate intensity aerobic exercise supports neuromotor and cognitive performances especially during the age of senescence" (28).

- Daily initiation frequency (% days with ≥30 min structured activity)
- Age-weighted preservation score (moderate intensity × age multiplier)
- Participant age (for age-dependent effects)

Cognitive Enrichment Features:

Theoretical basis: Cognitively demanding exercise enhances neuroplasticity beyond energy expenditure. "Exercises which exert large cognitive demands (e.g., involving learning processes, executive control, information processing speed) could have a higher impact on cognition" (6) and "HRV is sensitive to sustained attention, and shows an inverse correlation with cognitive load" (36).

- HRV-based cognitive load proxy (1/HRV during exercise sessions)
- Weekly activity variety (vertical, vigorous, sustained movement types)

A more quantitative summary of the features linked here.

Results

Neural Mechanism Feature Engineering and Principal Component Analysis

Two complementary PCA analyses were conducted to examine whether wearable-derived biometric patterns associate with memory performance. The **first analysis** (theory-driven) employed 15 neural mechanism literature-inspired features, while the **second analysis** (expanded) incorporated more demographics and biometric variables (18 total features).

Principal Component Structure and Variance Capture

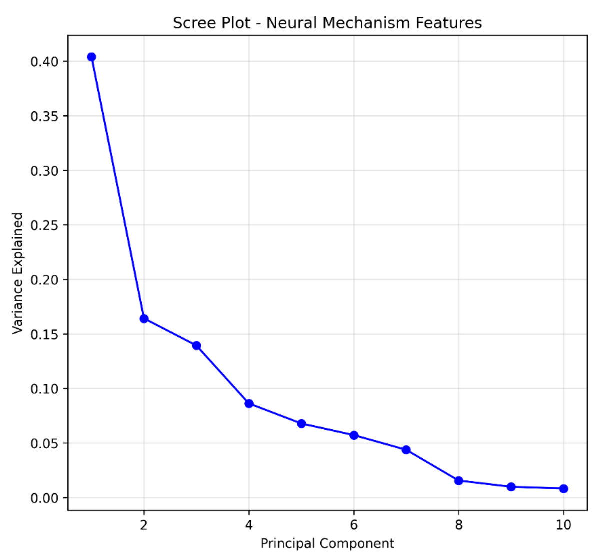

Figure 1A. Scree plot showing variance explained by each principal component, with PC1 capturing 40.4% of total variance, indicating a dominant pattern of neural mechanism optimization.

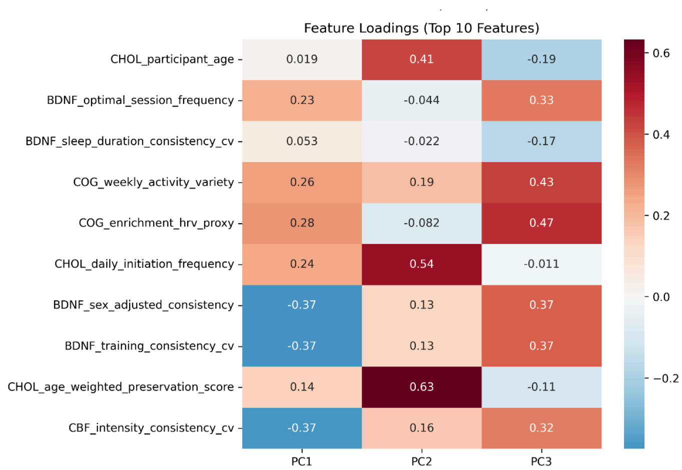

Figure 1B. Feature loadings heatmap. for top 10 neural mechanism features across the first three principal components. BDNF and CBF features show strong loadings on PC1, with consistency measures (blue) indicating that higher PC1 scores correspond to more consistent training patterns and greater CBF optimization (red).

The **first analysis** revealed that PC1 captured 40.4% of variance **(Figure 1A)**, demonstrating strong positive loadings from BDNF weeks meeting 3×/week threshold (0.402), CBF mean daily optimization score (0.371), and BDNF training consistency (-0.375). This means an individual scoring high in PC1 would more consistently meet 3x+ exercise days per week, have lower variability in training patterns, and spend more time in "fat burn" heart rate zones. The loadings pattern **(Figure 1B)** showed clear co-clustering of BDNF and CBF features on PC1.. The first three components explained 70.8% of total variance, indicating that neural mechanism-optimized exercise patterns represent coherent behavioral dimensions rather than random individual differences, at least by proxy.

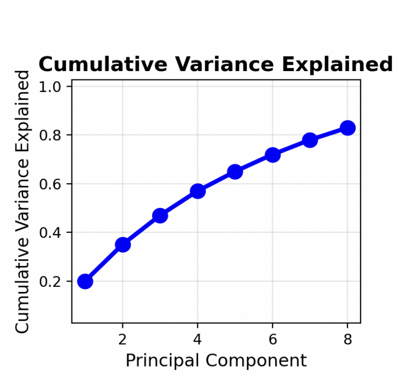

Figure 3A. Cumulative variance explained by PCs in the 18-feature analysis, first five components capturing 87% of total variance.

The **second analysis** maintained PC1 dominance but with reduced variance capture (37.3%), while PC2 increased substantially (19.6% versus 16.4% in the first analysis). The cumulative variance pattern (**Figure 3A**) demonstrated that the first five components captured 87% of total variance in the expanded feature space. Additionally, notable patterns emerged: several consistency features loaded inversely on the second analysis PC1, including BDNF training consistency CV (-0.374) and CBF intensity consistency CV (-0.369). This suggests that lower variability in training patterns may be associated with higher neural mechanism optimization scores. (Negative loadings on variables mean that higher PC1 scorers have lower CV values, which translates to more exercise consistency).

Cluster Analysis and Phenotype Identification

Figure 4B. K-means cluster sizes revealing four distinct phenotypes, with Cluster 1 representing the majority (66%) of participants and Cluster 2 (13%) showing highest optimization patterns.

K-means clustering identified four distinct participant phenotypes with markedly different neural mechanism proxy optimization profiles (**Figure 4B**). Cluster 2 participants (13.3% of participants) emerged as high neural mechanism optimizers with extreme PC1 scores (M = 4.521) and superior memory performance, averaging M = 0.724 versus M = 0.565 for the majority cluster on the immediate free recall task, representing about a 28% performance advantage. This represents a small subset of people whose exercise patterns strongly align with theoretical features based on neural mechanism literature and show improved memory performance.

The majority of participants (Cluster 1, 66.4%) showed negative PC1 scores (M = -0.806) and moderate memory performance (M = 0.565), suggesting that most individuals do not naturally engage in these theoretical mechanism-optimized exercise patterns.

Top Performer Differentiation Analysis

Comparison between top 25% and bottom 25% PC1 scorers revealed significant differences across multiple neural mechanism proxy features after Bonferroni correction ($\alpha = 0.0033$). Cognitive enrichment proxy features showed the largest effect sizes: weekly activity variety (Cohen's d = 2.256) and cholinergic daily initiation frequency (d = 1.930). BDNF optimization proxy features also significantly distinguished top performers, with weeks meeting 3×/week threshold showing a large effect size (d = 1.547), supporting the theoretical importance of consistent training frequency for BDNF elevation. CBF features showed that intensity CV had a negative effect size (d = -1.507), indicating that top neural mechanism optimizers demonstrate more consistent CBF-optimizing intensity patterns, which aligns with theoretical expectations about consistent exercise approaches.

However, when comparing participants by top quartile and bottom quartile memory performance directly, no neural mechanism features survived multiple testing correction, suggesting that mechanism optimization patterns may not directly translate to superior cognitive outcomes in this dataset. While Cluster 2 participants in the K Cluster analysis displayed higher PC1 scores and 28% improvement in immediate free recall memory performance, perhaps there is a threshold effect in which neural mechanism proxy optimization only benefits memory performance after someone reaches a certain threshold of activity or fitness level, which most participants don't achieve.

Machine Learning Prediction Performance

Random Forest classification using the first five principal components achieved 58.8% accuracy for predicting high versus low memory performance, representing modest but above-chance classification capability. The feature importance rankings revealed an unexpected pattern: PC4 and PC5 contributed most strongly to memory prediction (24.2% and 23.5% importance respectively), while PC1 showed the lowest predictive value for memory outcomes (14.2% importance). This challenges the assumption that neural mechanism optimization directly predicts cognitive performance and suggests that alternative and more personalized patterns represented in higher-order components may be more relevant for memory outcomes.

Methodological Considerations and Data Limitations

Both analyses maintained conservative participant-to-feature ratios (7.5:1 and 6.3:1 respectively) and employed appropriate multiple testing corrections. However, substantial missing data constraints limit interpretability: only 39.8% of participants had heart rate zone data essential for CBF and BDNF features, with median imputation used for missing values. This means that approximately 60% of CBF-related features and many BDNF features relied on imputed rather than observed values, potentially identifying patterns in the imputation process rather than genuine neural mechanism optimization behaviors.

Despite these limitations, the analysis demonstrates that neural mechanism-informed features form coherent behavioral patterns, with PC1 capturing 40.4% of variance and representing a dimension where BDNF consistency measures and CBF optimization features cluster together. However, the translation to cognitive benefits proved modest: while high-optimization participants (Cluster 2, 13.3% of sample) showed superior memory performance compared to the majority cluster (0.724 vs 0.565), the overall correlation between PC1 and memory performance was weak (r = 0.200). The 58.8% Random Forest classification accuracy for memory prediction indicates that these features provide only marginal predictive value above chance levels, suggesting that individual cognitive responses to exercise involve complex patterns not captured by population-level neural mechanism optimization principles.

Figures (with Captions) linked here.

Discussion

This analysis provides mixed support for the hypothesis that neural mechanism-informed exercise patterns show stronger associations with memory performance than conventional fitness metrics. The PCA successfully identified coherent behavioral patterns reflecting theoretical neural mechanism optimization, but the translation to superior cognitive outcomes proved more complex and individualized than anticipated.

Neural Mechanism Validation and Predictive Promise

The analysis strongly supported the idea that BDNF and CBF pathways work together, as these features consistently grouped together across both analyses. This aligns with research showing that exercise affects both CBF and BDNF through connected mechanisms (30). Cognitive enrichment proxy features showed predictive promise, with the largest differences ($d = 2.256$) between high and low optimizers, supporting research that mentally engaging exercise may have greater cognitive benefits (6).

However, the relationship between neural mechanism optimization and memory performance appears to operate primarily at the extremes. While participants grouped by memory performance showed no significant differences in neural mechanism proxy features after multiple testing correction, cluster analysis revealed that a small subset (13.3%) with extreme neural mechanism proxy optimization scores also demonstrated superior memory performance, suggesting threshold effects rather than linear relationships across the population.

Comparison with Manning et al. (2022) Findings

The results partially complement the original Manning findings. Manning et al. demonstrated that "recent low-to-moderate-intensity ('fat burn') cardiovascular activity was positively correlated with immediate and delayed recall performance" while "recent high intensity ('peak') activity was positively correlated with performance on the spatial learning task" (35). This project's approach identified similar patterns through CBF optimization scoring, which weighted fat burn activity positively.

Limitations and Future Directions

The substantial missing data (only 39.8% had complete heart rate zone data) meant that most neural mechanism features relied on imputed values, perhaps identifying statistical correlations instead of genuine physiological patterns.

The findings suggest that neural mechanism optimization effects may be most pronounced among highly active individuals who engage in truly optimized exercise patterns, while being diluted in broader population comparisons. Additionally, future research should expand to incorporate resistance training effects, since this could have different impacts on or associations with neural mechanisms related to cognition (17). Lastly, longitudinal data collection from wearable fitness trackers could be linked to broader cognitive domains beyond memory—such as learning—or perhaps introduce more regular interspersed cognitive assessments to better gauge individuals' cognitive associations with their activity patterns.

Towards Individualized Predictive Modeling

Translating these findings into practical cognitive assessment requires incorporating demographic factors and supervised learning through longitudinal tracking combined with regular cognitive assessments. The Rykov et al. (2024) study provides a compelling framework, demonstrating that "wearable physiological data combined with deep learning techniques can be used to predict the severity of mood and neuropsychiatric symptoms" by integrating "heart rate variability, sleep patterns, and physical activity data" with clinical outcomes (45).

Building on this approach, a new platform could integrate continuous biometric monitoring with intermittent app-based cognitive check-ins, allowing the system to learn individual response patterns over time. Such a system would address the key limitation observed here: while neural mechanism optimization patterns exist as coherent behavioral dimensions, their cognitive impact is highly individualized. A supervised learning approach could identify which specific optimization patterns predict cognitive improvements for each user, ultimately enabling machine learning-based adaptive prediction of individual memory and cognitive performance through digital biomarkers.

Data Availability

All analysis code and data used in the Manning et al. (2022) paper may be found at https://github.com/ContextLab/brainfit-paper.

This project used the Manning et al. (2022) dataset primarily, and additional developed code can be found at: https://github.com/lucagandrud/biometric-memory-project

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