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HERICIUM ERINACEUS AND COGNITIVE ENHANCEMENT IN HEALTHY YOUNG ADULTS: A NARRATIVE REVIEW

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ABSTRACT

Background: *Hericium erinaceus* (lion's mane mushroom) has been investigated as a potential cognitive enhancer, partly because preclinical studies link selected constituents to neurotrophic signaling. The clinical relevance of these mechanisms in cognitively intact young adults remains uncertain.
Objective: This narrative review evaluates human and mechanistic evidence relevant to cognitive enhancement by lion's mane, with emphasis on healthy young adults.
Methods: Targeted searches of biomedical databases, publisher websites, and reference lists identified human trials, mechanistic studies, and contextual reviews available through June 2026.
Results: Four studies directly examined healthy young or college-age adults. Acute studies reported changes in selected outcomes, including Stroop completion time, serial subtraction attempts, reaction-time measures, and pegboard performance. These findings were not consistent across cognitive domains or studies, and some reflected changes over time within the lion's mane condition rather than a clear advantage over placebo. A four-week college-age study found no cognitive benefit. More favorable results in older adults and people with cognitive impairment concern support of impaired function rather than enhancement above an intact baseline. Preclinical evidence most consistently supports nerve growth factor-related activity, whereas evidence involving brain-derived neurotrophic factor remains less developed and largely experimental.
Conclusions: Current evidence does not support broad claims that lion's mane improves cognition or memory in healthy young adults. Larger randomized trials using chemically characterized preparations, prespecified cognitive outcomes, and prospective mechanistic biomarkers are required.

KEYWORDS

Hericium Erinaceus, Lion's Mane, Cognition, Cognitive Enhancement, Young Adults, Neurotrophic Factors

CITATION

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1. Introduction

Cognitive enhancement refers to attempts to improve cognitive performance in people who do not have a clinically diagnosed cognitive disorder. This concept differs from treatment or supportive care in age-related and pathological cognitive decline, where the goal is commonly to preserve function, slow deterioration, or partially improve an impaired baseline. The distinction is central to the evaluation of purported nootropics because a positive finding in a clinically vulnerable population does not automatically demonstrate enhancement in a cognitively intact population (Farah et al., 2004; Greely et al., 2008).

Interest in enhancement is especially visible in academic and young-adult settings. Research in university populations has examined motivations, perceived benefits, and ethical or public-health questions associated with the use of cognitive-enhancement strategies (Sattler et al., 2013). In this context, intended use must be distinguished from demonstrated efficacy: claims of improved memory, attention, or executive function require direct evidence in cognitively intact participants and cannot be inferred from findings in clinical populations or from mechanistic plausibility alone.

Hericium erinaceus, commonly known as lion's mane mushroom, is one candidate evaluated for such effects. Selected constituents have shown neurotrophic activity in cell and animal models, particularly in experiments involving nerve growth factor and, less consistently, brain-derived neurotrophic factor-related signaling. These observations provide biological plausibility, but they do not establish that oral supplementation enhances cognition in humans (Cha et al., 2024; Szućko-Kociuba et al., 2023).

Healthy young adults represent a distinct test population. Their baseline cognitive performance is generally intact and may leave less room for measurable improvement than in older or cognitively impaired groups. Small changes may also appear only in selected tasks, while broad composite scores remain unchanged.

Consequently, studies in young adults require careful attention to the cognitive domain tested, the number of outcomes analyzed, baseline performance, practice effects, and whether a statistically positive result is replicated across related measures. Evidence from mild cognitive impairment or Alzheimer's disease can provide clinical context, but it cannot be treated as direct proof of enhancement above a healthy baseline.

A further difficulty is that the term lion's mane does not describe a single, chemically uniform intervention. Human studies have used fruiting body powder, fruiting body extracts, mycelial preparations, foods containing the mushroom, and products enriched in particular erinacines. These preparations differ in dose, extraction method, and reported concentrations of active constituents. The clinical literature therefore combines interventions that may not be biologically interchangeable (Ma et al., 2010; Surendran et al., 2025).

This narrative review evaluates the evidence for cognitive effects of *H. erinaceus* with a specific focus on healthy young adults. It has three objectives: to summarize the available human findings; to distinguish evidence for enhancement in cognitively intact individuals from evidence for support in older or impaired populations; and to assess how far proposed nerve growth factor- and brain-derived neurotrophic factor-related mechanisms are supported by human data. The review also identifies methodological and formulation-related limitations that currently prevent stronger clinical conclusions.

2. Materials and Methods

A targeted narrative literature search was conducted using PubMed, publisher databases and websites, and manual screening of the reference lists of key articles. The search covered literature available through June 2026. Search terms were used alone and in combination and included *Hericium erinaceus*, lion's mane, Yamabushitake, cognition, cognitive function, memory, attention, executive function, processing speed, psychomotor performance, mood, stress, sleep, healthy adults, young adults, nerve growth factor, brain-derived neurotrophic factor, neurogenesis, erinacine, hericenone, fruiting body, and mycelium.

English-language human studies were prioritized when they evaluated a clearly identifiable *H. erinaceus* intervention and reported cognitive, mood, stress, sleep, functional, or neurotrophic biomarker outcomes. Studies in healthy young adults were considered directly relevant to the principal review question. Trials in older adults, mild cognitive impairment, Alzheimer's disease, hearing impairment, or mood- and sleep-related populations were included as contextual evidence but were not classified as direct evidence of cognitive enhancement in healthy young adults.

Preclinical studies were included when they directly informed the proposed mechanisms discussed in the review, particularly nerve growth factor synthesis, neurite outgrowth, brain-derived neurotrophic factor-related signaling, neurogenesis, or nerve regeneration. Review articles were used to identify primary studies and to place the evidence in context; clinical conclusions were based preferentially on original human reports. Multi-ingredient interventions were excluded when the contribution of lion's mane could not be separated from that of other active components.

The evidence was organized into four descriptive categories: bioactive compounds and mechanistic findings; clinical studies in healthy young adults; studies in older or cognitively impaired populations; and human studies assessing neurotrophic biomarkers, mood, or sleep. For each human study, the population, design, intervention, duration, outcomes, principal findings, biomarker assessment, and relevance to healthy young adults were extracted into a structured evidence table.

This work was designed as a narrative rather than systematic review. No protocol was registered, no formal risk-of-bias instrument was applied, and no meta-analysis was performed. Instead, methodological features were appraised narratively, with attention to randomization, blinding, placebo control, sample size, intervention duration, formulation, outcome multiplicity, adjusted analyses, and the match between the study population and the review question. Because of substantial heterogeneity in preparations and outcome measures, quantitative pooling was not considered appropriate.

Interpretive weight was assigned according to relevance and study design. Placebo-controlled trials in healthy young adults were considered the most direct evidence for enhancement. Trials in older or impaired populations were used to evaluate possible cognitive support but were not allowed to substitute for young-adult evidence. Human biomarker studies were considered supportive only when the biomarker was measured prospectively, and preclinical experiments were used to establish plausibility rather than clinical efficacy. This hierarchy was applied throughout the synthesis to avoid overextending mechanistic or disease-population findings.

3. Results

3.1. Bioactive constituents and proposed neurotrophic mechanisms

The neurotrophic literature focuses mainly on hericenones and erinacines. Hericenones are associated principally with fruiting bodies, whereas erinacines are associated with cultured mycelia. Erinacines A, B, and C were originally characterized as diterpenoid xylosides that stimulated nerve growth factor synthesis in vitro; hericenones should not be treated as members of the same chemical class. Other constituents, including polysaccharides, are also present. This distinction is clinically relevant because fruiting body powders, concentrated extracts, unstandardized mycelial products, and erinacine A-enriched preparations cannot be assumed to provide equivalent chemical exposure (Kawagishi et al., 1994; Ma et al., 2010; Szućko-Kociuba et al., 2023).

The most established preclinical hypothesis concerns nerve growth factor. Early experimental work reported that erinacines isolated from *H. erinaceus* mycelia stimulated nerve growth factor synthesis. Later cellular studies described neurotrophic activity of mushroom-derived extracts and isolated compounds, including promotion of neurite outgrowth under experimental conditions (Kawagishi et al., 1994; Lai et al., 2013; Ma et al., 2010). These results support the existence of biologically active constituents, but they do not identify an effective human dose or demonstrate that orally administered preparations reproduce the same exposure in the central nervous system.

Animal findings extend the mechanistic rationale beyond isolated cells. In models of peripheral nerve injury, oral administration of aqueous *H. erinaceus* extract was associated with faster functional recovery and histological findings consistent with axonal regeneration. Peripheral nerve repair is not equivalent to cognitive enhancement, but the model supports a broader neuroregenerative potential that is compatible with nerve growth factor-related activity (Wong et al., 2012).

Evidence involving brain-derived neurotrophic factor is less extensive. In mice exposed to repeated restraint stress, erinacine A-enriched mycelium influenced the brain-derived neurotrophic factor/tropomyosin receptor kinase B/phosphoinositide 3-kinase/protein kinase B/glycogen synthase kinase 3 beta pathway and was accompanied by changes in monoaminergic signaling (Chiu et al., 2018). Separate animal work reported reduced anxiety- and depression-like behavior together with increased hippocampal neurogenesis after *H. erinaceus* extract administration (Ryu et al., 2018). These findings are relevant to mood and plasticity, but they remain animal data and do not establish a causal pathway for cognitive outcomes in humans.

Across the mechanistic literature, the support is therefore asymmetrical. Nerve growth factor-related activity has been reproduced across several preclinical approaches, including synthesis assays, neurite-related models, and nerve injury studies. Brain-derived neurotrophic factor-related evidence is promising but more limited and frequently embedded in stress or mood models. Neither line of evidence directly demonstrates that changes in neurotrophic signaling mediate cognitive effects after supplementation in healthy adults.

3.2. Evidence in healthy young adults

Four published studies provide the most direct evidence in healthy young or college-age adults. Docherty et al. (2023) conducted a randomized, double-blind, placebo-controlled pilot study in healthy adults aged 18-45 years. Participants received 1.8 g of *H. erinaceus*, with testing after a single dose and again after 28 days. The protocol included computerized cognitive tasks and measures of stress and mood.

At 60 minutes after the acute dose, participants assigned to lion's mane completed the Stroop task more quickly. The wider battery did not show a consistent treatment advantage, and some word-recall outcomes favored placebo. After 28 days, the principal chronic finding was a trend toward lower subjective stress rather than a clear cognitive benefit. The study therefore identified a narrow task-level signal, not a reproducible improvement across cognition or memory (Docherty et al., 2023).

Surendran et al. (2025) evaluated a single 3 g dose of a standardized fruiting body extract in healthy adults aged 18-35 years using a double-blind, randomized, placebo-controlled crossover design. Composite measures of cognition and mood did not differ between the intervention and placebo conditions. A pegboard measure improved after the extract, providing a psychomotor signal without evidence of generalized cognitive enhancement.

Grozier et al. (2022) examined four weeks of supplementation in a college-age cohort. Participants consumed 10 g per day of *H. erinaceus* incorporated into muffins in a placebo-controlled parallel study. The intervention did not produce a measurable benefit in the cognitive outcomes or markers of metabolic flexibility assessed in the trial. This null result is important counterevidence to broad enhancement claims in young adults.

La Monica et al. (2023) used a randomized, double-blind, placebo-controlled, three-condition crossover design in 40 healthy adults aged 18-50 years. On separate visits, participants received placebo, guayusa extract, or a single 1 g dose of 100% organic Nordic lion's mane fruiting bodies. Within the lion's mane condition, the number of attempts on Serial Sevens and reaction-time measures in the N-Back and Go/No-go tasks improved at two hours relative to earlier or baseline measurements. However, the study did not demonstrate a consistent lion's mane advantage over placebo across the full cognitive battery. The findings are therefore best interpreted as exploratory, task- and time-specific changes rather than evidence of broad cognitive enhancement.

Across the four publications, positive findings were confined to selected outcomes: Stroop completion time, within-condition changes in serial subtraction or reaction time, and pegboard performance. These signals occurred in different domains and with different preparations, while the four-week college-age study was negative. No cognitive domain has shown consistent replication across the young-adult studies, and none of these trials measured nerve growth factor or brain-derived neurotrophic factor. A direct link between the behavioral findings and the proposed neurotrophic mechanisms therefore remains untested.

The evidence also combines acute and repeated exposure. La Monica et al. and Surendran et al. assessed single doses, Docherty et al. included both an acute assessment and a 28-day phase, and Grozier et al. examined four weeks of intake. The interventions ranged from fruiting body material and standardized extracts to mushroom incorporated into food. Cognitive batteries and analysis strategies also differed, preventing a straightforward comparison of effect sizes. The available data cannot determine whether the isolated positive findings represent reproducible treatment effects, sensitivity of particular tasks, practice or time effects, or chance findings among multiple outcomes.

3.3. Evidence in older adults and cognitively impaired populations

Studies in older adults and cognitively impaired populations have generally reported more favorable findings, although the interventions and outcome measures differ. Mori et al. (2009) enrolled adults aged 50-80 years with mild cognitive impairment in a double-blind placebo-controlled trial. Participants received 3 g per day of *H. erinaceus* for 16 weeks, followed by observation after discontinuation. Scores on a cognitive function scale improved during supplementation and declined after the intervention ended.

Saitsu et al. (2019) studied adults aged 50 years or older using a randomized, double-blind, placebo-controlled design. Participants received 3.2 g per day of fruiting body powder for 12 weeks. Improvement was reported mainly on the Mini-Mental State Examination, whereas the Benton visual retention and verbal paired-associate measures did not show equally consistent effects. The pattern was therefore not uniform across the cognitive instruments used.

Li et al. (2020) conducted a 49-week pilot randomized double-blind placebo-controlled study of erinacine A-enriched mycelia in patients with mild Alzheimer's disease. The trial reported more favorable cognitive and functional outcomes in the active group, including measures based on the Cognitive Abilities Screening Instrument, the Mini-Mental State Examination, and instrumental activities of daily living. Biomarkers were included, but the clinical findings did not establish that neurotrophic changes mediated the cognitive outcomes.

These trials differ from the young-adult studies in baseline cognitive status, age, duration, formulation, and the type of outcome used. Global screening instruments and disease-related functional measures are designed to detect change in populations with impairment and are not direct equivalents of computerized tasks intended to identify subtle enhancement in healthy participants. Their results are therefore clinically relevant to possible cognitive support in vulnerable populations but address a different question from enhancement above an intact baseline.

The older and impaired-population studies also provide limited information about durability. The decline observed after discontinuation in the Mori trial raises the possibility that continued exposure may be required, but this pattern was reported in mild cognitive impairment and has not been established in healthy adults. The longer Li trial shows that extended administration can be studied, yet its findings remain tied to a clinical population and an erinacine-enriched mycelial preparation. Duration, baseline impairment, and formulation are therefore difficult to separate in the current literature.

3.4. Biomarker, mood, and sleep-related evidence

A small group of human studies provides partial biomarker or mood-related context. Bizjak et al. (2024) evaluated an erinacine A-enriched preparation for eight weeks in healthy adults aged 55-75 years. The randomized double-blind placebo-controlled pilot study included non-verbal cognitive speed measures and serum brain-derived neurotrophic factor. Perceptual speed improved only after statistical adjustment for baseline performance and demographic factors. Serum brain-derived neurotrophic factor changed differently between groups, increasing numerically in the intervention group and decreasing in the placebo group. The small sample and adjusted cognitive result limit the certainty of the finding.

Chan et al. (2022) randomized 80 hearing-impaired adults aged 50-79 years to erinacine A-enriched mycelia or placebo for eight months; 59 participants completed the trial. In the full analyzed sample, changes in the audiometric outcomes, serum nerve growth factor, and serum brain-derived neurotrophic factor did not differ significantly between groups. In a subgroup aged 65 years or older, selected hearing measures and nerve growth factor differed between groups, whereas brain-derived neurotrophic factor did not show a significant treatment effect. Cognition was not assessed. The study therefore provides only indirect, subgroup-based biomarker context for the present review.

Mood- and sleep-focused studies provide additional but indirect evidence. Nagano et al. (2010) randomized 30 women to cookies containing 2 g per day of powdered *H. erinaceus* fruiting body or placebo for four weeks; 26 participants were analyzed. Depression and indefinite-complaint scores decreased from baseline in the active group, but the change in the total depression score did not differ significantly between groups. Between-group differences were limited to selected items of the indefinite-complaints scale, and sleep quality did not show a significant benefit. Vigna et al. (2019) randomly allocated 77 adults with overweight or obesity, all following a low-calorie diet, to diet alone or diet plus three capsules per day of a mixed mycelium and fruiting body preparation for eight weeks. The study was not placebo-controlled or blinded. Scores for anxiety and selected mood- and sleep-related symptoms decreased from baseline in the supplemented group; however, the design did not provide a blinded placebo comparison. In a selected subgroup of 10 symptomatic participants, serum precursor brain-derived neurotrophic factor increased, whereas mature brain-derived neurotrophic factor did not change significantly at the end of supplementation. Neither study tested cognitive enhancement in healthy young adults.

Table 1. Summary of human studies of Hericium erinaceus relevant to cognition, mood, and neurotrophic biomarkers

Study	Population	Design	Intervention / duration	Outcomes	Main findings	Neurotrophic biomarkers	Relevance to healthy young adults
Docherty et al. (2023)	Healthy adults, 18-45 years	Randomized, double-blind, placebo-controlled pilot	1.8 g *H. erinaceus*; acute assessment and 28 days	Cognition, stress, mood	Faster Stroop performance after a single dose; trend toward lower subjective stress after 28 days; no consistent broad cognitive benefit	Not measured	Direct evidence; supports cautious interpretation of task-specific effects
La Monica et al. (2023)	40 healthy adults, 18-50 years	Randomized, double-blind, placebo-controlled, three-condition crossover	Single 1 g dose of 100% organic Nordic lion's mane fruiting bodies	Go/No-go, Serial Sevens, N-Back, subjective cognitive ratings and happiness	Within-condition improvements in selected attempts and reaction-time measures at 2 hours; no consistent broad advantage over placebo	Not measured	Direct evidence, but exploratory and task/time-specific
Surendra n et al. (2025)	Healthy adults, 18-35 years	Double-blind randomized placebo-controlled crossover	3 g standardized fruiting body extract; acute assessment	Composite cognition, mood, psychomotor performance	No improvement in composite cognition or mood; improved pegboard performance	Not measured	Direct evidence; suggests possible task-specific rather than global effects

Study	Population	Design	Intervention / duration	Outcomes	Main findings	Neurotrophic biomarkers	Relevance to healthy young adults
Grozier et al. (2022)	College-age adults	Placebo-controlled parallel longitudinal study	10 g/day in muffin form; 4 weeks	Cognition and metabolic flexibility	No measurable cognitive benefit	Not measured	Important negative study in young adults
Bizjak et al. (2024)	Healthy adults, 55-75 years	Randomized, double-blind, placebo-controlled pilot	Erinacine A-enriched *H. erinaceus*; 8 weeks	Non-verbal speed tests, brain-derived neurotrophic factor, neuropeptide Y, microbiota	Perceptual speed improved only after adjustment; biomarker change differed between groups	Brain-derived neurotrophic factor	Mechanistically relevant, but not young-adult evidence
Saitsu et al. (2019)	Adults aged 50 years or older	Randomized, double-blind, placebo-controlled	3.2 g/day fruiting body powder; 12 weeks	Mini-Mental State Examination, Benton test, verbal paired-associate learning	Improvement mainly in the Mini-Mental State Examination; other tests less consistent	Not measured	Possible older-adult effect; not evidence for young-adult enhancement
Mori et al. (2009)	Adults aged 50-80 years with mild cognitive impairment	Double-blind placebo-controlled trial	3 g/day *H. erinaceus*; 16 weeks plus follow-up	Cognitive function scale	Improvement during intake; decline after discontinuation	Not measured	Positive trial in mild cognitive impairment; not directly generalizable
Li et al. (2020)	Patients with mild Alzheimer's disease	Pilot randomized double-blind placebo-controlled trial	Erinacine A-enriched mycelia; 49 weeks	Cognitive screening, function, biomarkers	More favorable cognitive and functional outcomes than placebo	Brain-derived neurotrophic factor included, but mediation not established	Clinical population only; not enhancement evidence
Vigna et al. (2019)	77 adults with overweight or obesity; biomarker subgroup n=10	Random allocation to low-calorie diet alone or diet plus supplement; not placebo-controlled or blinded	Three capsules/day of mixed mycelium and fruiting body preparation; 8 weeks	Mood, sleep, binge eating, serum pro-BDNF and BDNF	Anxiety and selected mood/sleep scores decreased from baseline in the supplemented group; the study lacked a blinded placebo comparison; pro-BDNF increased in a selected subgroup, while mature BDNF did not change significantly at 8 weeks	Pro-BDNF and BDNF	Indirect mood/biomarker evidence; not a cognition trial
Nagano et al. (2010)	30 women with nonspecific/ menopausal complaints; 26 analyzed	Randomized, double-blind, placebo-controlled trial	2 g/day powdered fruiting body in cookies; 4 weeks	Depression, sleep quality, menopausal and indefinite complaints	Within-group decreases in depression and complaint scores; no significant between-group change in total depression score; selected complaint items differed; no clear sleep benefit	Not measured	Mood-related context only; not evidence of cognitive enhancement

Study	Population	Design	Intervention / duration	Outcomes	Main findings	Neurotrophic biomarkers	Relevance to healthy young adults
Chan et al. (2022)	80 hearing-impaired adults, 50-79 years; 59 completed	Double-blind, randomized, placebo-controlled trial	2 g/day erinacine A-enriched mycelia; 8 months	Hearing outcomes, NGF, BDNF	No significant overall between-group effects; selected hearing measures and NGF differed only in participants aged 65 years or older; cognition was not assessed	NGF and BDNF	Indirect subgroup-based biomarker evidence only

Note. Findings are reported at the level supported by each study. Within-condition changes are distinguished from consistent superiority over placebo, and results from older or clinical populations are not treated as evidence of enhancement in healthy young adults. BDNF, brain-derived neurotrophic factor; NGF, nerve growth factor.

4. Discussion

The central finding of this review is that evidence for cognitive enhancement by *H. erinaceus* in healthy young adults remains limited and inconsistent. Across four direct studies, positive results were restricted to selected task-level outcomes, including Stroop completion time, serial subtraction or reaction-time measures, and pegboard performance. The findings were not reproduced consistently across cognitive domains, and the four-week college-age study was negative. The evidence is therefore more compatible with exploratory, task-specific signals than with a generalized improvement in cognition, memory, or executive function (Docherty et al., 2023; Grozier et al., 2022; La Monica et al., 2023; Surendran et al., 2025).

This distinction matters because a single significant task cannot represent cognition as a whole. Cognitive performance is multidimensional and includes attention, processing speed, inhibitory control, learning, working memory, episodic memory, and psychomotor coordination. A supplement could theoretically affect one domain without affecting others. At the same time, trials that test many outcomes create opportunities for isolated positive results, particularly when samples are small. Replication of the same domain with comparable tasks is therefore more informative than significance on unrelated measures across separate pilot studies.

The more favorable results reported in older adults, mild cognitive impairment, and mild Alzheimer's disease should not be dismissed, but they answer a different clinical question. Change from an impaired baseline may reflect support of compromised function or symptomatic improvement during treatment rather than enhancement above normal performance. These studies provide a rationale for therapeutic research in vulnerable populations, but they cannot substitute for evidence in cognitively intact young adults (Li et al., 2020; Mori et al., 2009; Saitsu et al., 2019).

Baseline status may partly explain why effects are easier to detect in vulnerable populations. Screening tools such as the Mini-Mental State Examination have greater room to register improvement when baseline scores are reduced, whereas healthy young participants may perform near the upper range on standard tasks. Nevertheless, a ceiling explanation cannot be assumed after a negative trial. Studies should select demanding, sensitive measures designed for healthy populations and should prespecify the primary cognitive domain. Otherwise, null findings may reflect either a genuinely ineffective intervention or an insensitive measurement strategy.

The mechanistic literature provides a plausible but unconfirmed framework. Nerve growth factor-related effects are the most repeatedly described preclinical findings, while brain-derived neurotrophic factor-related signaling and hippocampal neurogenesis provide additional experimental hypotheses. Human biomarker evidence is limited and does not establish mediation. Bizjak et al. assessed serum brain-derived neurotrophic factor in older healthy adults; Chan et al. found no overall between-group neurotrophin effect and reported a nerve growth factor difference only in an older subgroup; Vigna et al. observed an increase in precursor brain-derived neurotrophic factor, not mature brain-derived neurotrophic factor, in a small symptomatic subgroup. None of these studies linked a neurotrophic biomarker change to cognitive enhancement in healthy young adults (Bizjak et al., 2024; Chan et al., 2022; Vigna et al., 2019).

Peripheral biomarker measurements also require caution. Serum nerve growth factor or brain-derived neurotrophic factor does not directly measure regional signaling or synaptic plasticity in the central nervous system. Vigna et al. explicitly noted the uncertain relationship between circulating brain-derived neurotrophic factor and concentrations in the brain, as well as poor reproducibility across peripheral biomarker studies. Peripheral measures are therefore most informative when collected prospectively alongside prespecified behavioral outcomes and interpreted with complementary methods rather than as proof of a central mechanism (Vigna et al., 2019).

Formulation heterogeneity is another major obstacle. The term *H. erinaceus* has been applied to fruiting body powder, aqueous or other extracts, foods, mycelial products, and preparations enriched in erinacine A. Doses reported in grams cannot be compared directly when the content of active constituents is unknown. Even interventions with the same nominal mushroom dose may differ in extraction yield, substrate, fruiting body-to-mycelium ratio, stability, and bioactive composition. Without chemical characterization, a positive or negative trial may be difficult to reproduce and cannot be generalized confidently to commercial products (Ma et al., 2010; Szućko-Kociuba et al., 2023).

Duration may further influence outcomes. Acute studies can identify transient effects on attention, processing speed, or psychomotor performance, whereas putative neurotrophic or neuroplastic effects might require repeated exposure. Conversely, a longer intervention does not guarantee efficacy, as shown by the negative four-week college-age study. Trials should therefore distinguish acute pharmacodynamic questions from chronic supplementation questions and should include post-discontinuation assessments when persistence of effect is relevant.

The distinction between statistical and clinical relevance is equally important. A faster response on one computerized task may be statistically detectable without producing a meaningful change in daily academic, occupational, or functional performance. None of the young-adult studies establishes a clinically important threshold for benefit, and the available outcomes do not demonstrate improved learning, examination performance, sustained attention in real-world settings, or durable memory. Future trials should report effect sizes and confidence intervals, not only probability values, and should define in advance what magnitude of change would be considered meaningful.

Pilot studies are useful for identifying candidate outcomes and estimating variability, but they are not designed to settle efficacy. Small samples are more vulnerable to baseline imbalance and unstable estimates, while extensive cognitive batteries increase the number of statistical comparisons. Findings that emerge only after covariate adjustment, only within one treatment condition over time, or on one of many outcomes should be treated as hypothesis-generating until independently replicated. This applies to the adjusted perceptual-speed finding in Bizjak et al. (2024) and to the isolated task-level findings reported in younger adults.

The certainty of evidence for enhancement in healthy young adults should be considered low. The direct evidence base consists of four small studies using different preparations, doses, exposure periods, cognitive batteries, and statistical approaches. Positive results have not been replicated consistently within the same cognitive domain, and mechanistic biomarkers were absent from all four young-adult studies. These limitations do not prove that lion's mane is ineffective; they mean that the current evidence cannot support broad efficacy claims.

From a practical perspective, the present evidence does not establish an evidence-based dose, preferred formulation, treatment duration, or target outcome for healthy young adults. Gram doses of whole mushroom or fruiting body material cannot be equated with milligram exposure to a quantified erinacine, and efficacy of a research preparation cannot be assumed for retail products. The absence of a consistent cognitive benefit also means that mechanistic plausibility should not be used as a substitute for demonstrated performance improvement. At present, the literature supports continued investigation rather than a general recommendation for cognitive enhancement.

This review also has limitations. It was narrative, not systematic, and did not use a registered protocol, duplicate screening, formal risk-of-bias scoring, or meta-analysis. Targeted searching and reference screening may have missed relevant reports. The inclusion of mechanistic, cognitive, mood, sleep, and biomarker evidence allowed a broad synthesis but increased heterogeneity. The conclusions were therefore deliberately weighted toward direct placebo-controlled human studies and toward the match between each population and the specific question of enhancement in healthy young adults.

Future studies should use adequately powered randomized placebo-controlled designs and report an a priori primary outcome. Cognitive batteries should separate attention, executive function, processing speed, working memory, episodic memory, and psychomotor performance rather than treating all outcomes as

interchangeable. Correction for multiple comparisons and transparent reporting of null findings are important, particularly when numerous computerized tasks are administered.

Preparations should be chemically characterized, with clear identification of fruiting body, mycelium, extraction method, dose, and quantified erinacines, hericenones, or other relevant constituents. Dose-response studies should compare acute and chronic administration and should include adherence and tolerability reporting. Direct comparison of standardized fruiting body and mycelial preparations could help determine whether different clinical signals reflect distinct chemical profiles.

Methodological transparency should accompany chemical standardization. Trials should be prospectively registered, publish a statistical analysis plan, distinguish primary from exploratory outcomes, and report all prespecified cognitive results. Baseline diet, caffeine use, sleep, stress, and previous supplement exposure may influence performance and should be measured or controlled when feasible. Repeated-testing designs should address practice effects, while crossover studies should justify washout periods. These steps would reduce selective interpretation and make positive and negative studies easier to compare.

Mechanistic endpoints should be incorporated prospectively rather than inferred after a behavioral result. Trials should assess nerve growth factor, brain-derived neurotrophic factor, precursor brain-derived neurotrophic factor, and related markers together with cognition. Where feasible, peripheral measures should be complemented by neuroimaging, electrophysiology, stress-related biomarkers, or microbiome analyses. The most useful future studies will determine not only whether *H. erinaceus* affects performance, but also which population responds, which formulation is active, what duration is required, and whether biological changes track the cognitive outcome.

5. Conclusions

Preclinical studies of *Hericium erinaceus* have reported neurotrophic activity, and human studies have produced selected cognitive, psychomotor, mood, or functional findings. Nevertheless, clinical results vary substantially by population, preparation, duration, outcome, and analytical approach. In healthy young adults, four direct studies provide mixed evidence. Isolated task-level changes have not been accompanied by consistent improvement in broader cognition or memory.

More favorable findings in older adults, mild cognitive impairment, and mild Alzheimer's disease may indicate greater potential for supporting vulnerable or impaired function, but they cannot be extrapolated directly to enhancement above a healthy young baseline. Nerve growth factor-related mechanisms are the strongest preclinical rationale, while brain-derived neurotrophic factor-related evidence is less developed. Human studies have not yet demonstrated that neurotrophin modulation mediates cognitive effects.

The current evidence therefore does not support strong general claims that lion's mane improves cognition or memory in cognitively intact young adults. Standardized preparations, larger trials, prespecified cognitive domains, and integrated mechanistic measurements are required before a reliable efficacy conclusion can be reached.

Ethical Considerations and Data Availability

Ethical approval and informed consent: Not applicable. This narrative review did not involve the collection of new data from human participants or animals.

Data availability: All evidence discussed in this review is derived from previously published literature cited in the manuscript.

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