When Financial Stress Costs More Than Money: A Neurofinancial Literacy Intervention to Improve Cognitive Performance and Reduce Financial Anxiety Among International Postgraduate Students

— An Action Research Study

Ayesha Sayeed

Arden University, School of Psychology

ayeshasayeed42@gmail.com

Abstract

International postgraduate students represent a financially vulnerable population, frequently managing tuition debt and living costs alongside the cognitive demands of advanced study. Financial stress chronically activates the hypothalamic-pituitary-adrenal (HPA) axis, elevating cortisol and impairing prefrontal cortex (PFC)-dependent functions including working memory, cognitive flexibility, and financial decision-making — a pattern referred to here as the Debt Brain Paradox. Despite this, no evaluated intervention combines neuropsychoeducation, cognitive reframing, and applied financial engineering skills to address both the cognitive and anxiety dimensions of this problem.

This action research study (Cycle 1) developed and evaluated a six-session Neurofinancial Literacy Intervention (NLI) with 15 international postgraduate students (from 18 recruited; attrition = 16.7%) experiencing moderate to severe financial anxiety. The HPA-axis dysregulation and PFC disruption account is treated throughout as a theoretically grounded interpretive framework, not a demonstrated causal mechanism; direct neurobiological evidence will be sought in Cycle 2. Hypothesis-generating pre-to-post results showed positive change across all four outcome measures: executive function composite score (M = 53.8 to 62.4; d = 0.99, 95% CI [0.38, 1.59]); financial anxiety on the Financial Anxiety Scale (M = 14.9 to 11.2; d = 1.18, 95% CI [0.52, 1.83]); financial decision quality on the researcher-developed Financial Decision Scenarios Questionnaire (46.7% to 61.3%; d = 1.31, 95% CI [0.60, 2.00]); and working memory accuracy (63.1% to 69.8%; d = 0.84, 95% CI [0.25, 1.42]). The absence of a control group, selection of participants at elevated baseline anxiety (raising regression-to-the-mean as a competing explanation), practice effects on cognitive measures, and small sample size preclude causal inference; findings are best treated as initial signals warranting confirmation through controlled design. Thematic analysis of reflective journals identified four themes: neurological reframing; cognitive/threat distinction; financial engineering empowerment; and future agency.

Key Words: *neurofinance, financial stress, prefrontal cortex, executive function, action research*

1. Introduction and Context

International postgraduate students form some of the most financially vulnerable groups on contemporary campuses. They pay tuition fees and living costs — often through commercial loans in foreign currencies — while managing the cognitive demands of advanced study and the emotional burden of cultural displacement (Norvilitis & Mao, 2013; Richardson et al., 2013). The psychological consequences include heightened anxiety, poor academic engagement, and increased risk of programme dropout (Archuleta et al., 2013). Less well understood are the neurological dimensions of this problem.

1.1 Theoretical Background and Literature Review

The impetus for this study came from observations made in a financial support office at a European university campus. Students did not merely describe financial difficulty; they reported an inability to think coherently about finances, tendencies toward financial information avoidance, and a pervasive sense that they could not act on financial knowledge they already possessed. Neurofinancial research identifies exactly this pattern: chronic financial stress is associated with cognitive impairments in the domains these students described (Arnsten, 2015; Camerer et al., 2005; Knutson & Bossaerts, 2007).

The proposed neurobiological pathway runs through the hypothalamic-pituitary-adrenal (HPA) axis. Chronic financial stress is theorised to cause sustained elevation of cortisol, which in turn disrupts prefrontal cortex (PFC) functioning — impairing working memory, cognitive flexibility, inhibitory control, and prospective planning (Arnsten, 2015; Lupien et al., 2009; Kahneman, 2011). The paradox is therefore: those who most need cognitive capacity for strategic financial decision-making may have that capacity most compromised by the very stress their financial situation generates. The current study labels this the Debt Brain Paradox. It is essential to emphasise that this neurobiological account functions as a theoretically grounded interpretive framework for the present study, not as an empirically verified causal mechanism. The observed cognitive and anxiety outcomes are interpreted

as consistent with this model, but no direct neurobiological measurement was conducted in Cycle 1. Cycle 2 will include salivary cortisol sampling and, where feasible, neuroimaging to test this pathway directly. Mani et al. (2013) provided influential behavioural evidence, demonstrating that financial scarcity occupies cognitive space — reducing performance on working memory and fluid intelligence tasks by the equivalent of roughly 13 IQ points. Mullainathan and Shafir (2013) extended this framework to show how scarcity captures attention automatically, leaving fewer cognitive resources for other demands. The practical implication is that financial stress functions as both a wellbeing problem and a learning and decision-making impairment.

Yet existing university financial support operates on an information-deficit assumption — providing budgeting advice, debt-management programmes, and financial literacy workshops that deliver more financial information into a system already compromised by stress (Gathergood, 2012; Lusardi & Mitchell, 2014). Cognitive load theory suggests this approach is doubly problematic under stress conditions (Sweller, 1988; Thaler & Sunstein, 2008). The NLI was designed to address this gap by targeting the cognitive and anxiety dimensions first.

The research question driving this Cycle 1 investigation is: *How can a structured Neurofinancial Literacy Intervention improve cognitive performance and reduce financial anxiety among internationally enrolled postgraduate students experiencing chronic financial stress*

2. Methodology & Research Approach

The study employs action research, a practitioner-driven approach characterised by iterative cycles of planning, acting, observing, and reflecting (Kemmis & McTaggart, 2005; McNiff, 2017). Action research is appropriate here because it situates the practitioner-researcher within the intervention context, enabling the development of practice-based knowledge. A convergent mixed-methods design was used, combining quantitative pre-post measures with qualitative thematic analysis of reflective journal data to allow triangulation (Creswell & Plano Clark, 2018). The present study constitutes Cycle 1; its findings will inform the design of Cycle 2, which will incorporate a waitlist control group, salivary cortisol sampling, and longitudinal follow-up.

2.1 Participants

A total of 18 international postgraduate students were recruited using purposive sampling from the financial support services department and postgraduate student associations of the university. The inclusion criteria were: (a) being an international postgraduate student; (b) having a Financial Anxiety Scale (FAS) score of 10 or above (moderate to severe financial anxiety); (c) experiencing debt, living cost challenges, or foreign exchange challenges; and (d) being able to participate in group discussions due to proficiency in English language. The participants came from different disciplinary courses such as business, engineering, social sciences, and health sciences; the sample was not limited to students from finance or financial engineering disciplines. Therefore, the interpretation "independent of domain knowledge" on the findings related to financial decision quality in an earlier draft has been withdrawn (refer to section 4.1). Three participants did not complete the course: two participants had scheduling problems and one had personal issues. Thus, the final analytic sample size became N = 15 (dropout rate: 3/18 = 16.7%). The per-protocol approach was used for analysis; intention-to-treat analysis for Cycle 2 is recommended. Participant characteristics are described in Table 1.

Table 1. Participant Demographic and Financial Characteristics (N = 15)

Characteristic	Category	n (%)
Gender	Female	9 (60.0)
	Male	6 (40.0)
Mean age, years (SD)	23.1 (1.8)	—
Nationalities represented	10 countries	—
Primary region of origin	Asia	6 (40.0)
	Middle East	4 (26.7)
	Africa	3 (20.0)
	Latin America	2 (13.3)
Disciplines represented	Business / Management	5 (33.3)
	Engineering (non-finance)	4 (26.7)
	Social Sciences	3 (20.0)
	Health Sciences	2 (13.3)
	Other	1 (6.7)
FAS severity at baseline	Moderate (score 10–14)	8 (53.3)
	Severe (score 15–21)	7 (46.7)
Primary financial stressor	Tuition debt	9 (60.0)
	Living cost deficit	4 (26.7)
	Combined debt and deficit	2 (13.3)

2.2 Measures

Financial Anxiety Scale (FAS): The FAS (Archuleta et al., 2013) is a seven-item self-report scale with a range of 0–21, with established cut-points: 0–5 (low), 6–9 (mild), 10–14 (moderate), and 15–21 (severe) anxiety. Published internal consistency: Cronbach's α = .87. Administered at Week 0 (pre-intervention) and Week 12 (post-intervention). Because participants were selected on the basis of FAS ≥ 10, the observed mean reduction may partly reflect regression to the mean; this threat to internal validity is acknowledged in Section 5.2 and cannot be ruled out without a control condition.

Executive Function Composite Score: Participants completed two validated neurocognitive tasks in standardised order: the Stroop Color-Word Test (SCWT; Golden, 1978), assessing cognitive inhibition via the interference condition T-score, and Trail Making Test Part B (TMT-B; Reitan, 1958), assessing cognitive flexibility via task completion time. Scores on each were linearly transformed to a common 0–100 scale using published normative data and then averaged to produce a composite. It should be noted that identical stimulus forms were administered at both pre- and post-intervention time points; alternate forms of the SCWT and TMT-B were not used. The possibility that practice effects — that is, familiarity with task stimuli and format on re-administration — contributed to observed score improvements cannot therefore be excluded. This is acknowledged as a limitation and discussed further in Section 5.2.

Financial Decision Scenarios Questionnaire (FDSQ): A 20-item researcher-developed instrument. Each item presents a financial scenario with three response options; one option is designated optimal via expected value and net present value calculations, while the remaining two options exploit known cognitive biases (present bias, loss aversion amplification, representativeness heuristic, and sunk cost fallacy). Content validity was established through consensus review by three independent certified financial professionals prior to administration. In-sample internal consistency: Cronbach's $\alpha = .71$. Although $\alpha = .71$ meets the conventional acceptability threshold (Nunnally, 1978), it is at the lower end; this likely reflects intentional item-type heterogeneity (multiple distinct bias types are represented), and the full 20-item set is reproduced in Appendix A for reader scrutiny. Primary outcome: percentage of optimal responses selected.

Digit Span Test: The Digit Span subtest from the WAIS-IV (Wechsler, 2008) was administered using standard forward and backward conditions. Raw combined scores were converted to scaled scores using WAIS-IV normative data and expressed as a composite accuracy percentage. Test-retest reliability: $r = .83$ (Wechsler, 2008).

Qualitative Instruments: A structured weekly reflective journal using a four-prompt template was completed by participants at each session. The facilitator maintained systematic observation records after each session. Thematic analysis followed Braun and Clarke's (2006) six-phase method. Inter-rater reliability was established through independent coding of a randomly selected 30% of journals by a second coder who was blind to all quantitative outcomes: Cohen's κ = .82 (Landis & Koch, 1977).

2.3 Ethical Considerations

Ethical clearance was received before starting data collection from the ethics board at the university level. A written consent to participate was necessary, whereby participants were assured that they can withdraw from the study at any point without facing any repercussions concerning their course results. Confidentiality was maintained by use of anonymous identifiers, i.e., numbers, rather than names. The ethical guidelines adopted in the study include the 2021 guidelines issued by the British Psychological Society and also the 2013 Declaration of Helsinki by World Medical Association.

2.4 Data Analysis

Given the small sample, practical significance is emphasised alongside statistical significance. Cohen's d was computed as the mean difference divided by the pooled standard deviation of pre- and post-scores (Cohen, 1988): d = (Mpost − Mpre) / SDpooled. Ninety-five percent confidence intervals for d were obtained using the non-central t-distribution method. Normality of all dependent variables was confirmed at both time points using the Shapiro-Wilk test (all p > .05). Pre-to-post differences were assessed with two-tailed paired-samples t-tests (α = .05) in IBM SPSS Statistics version 27.0. Because four outcomes were tested simultaneously, readers should note that the family-wise error rate is inflated; applying a Bonferroni correction would set the per-test threshold at α = .0125, and all four outcomes meet this more conservative threshold. No corrections were applied in the reported analyses given the exploratory, hypothesis-generating purpose of Cycle 1, but results should be interpreted accordingly.

3. The Neurofinancial Literacy Intervention (NLI)

The NLI was delivered via six sessions of 90 minutes each, delivered fortnightly across one academic semester. Theories were incorporated into practical exercises that were easy for participants to understand; academic language was never employed. This fortnightly schedule was intentional since it gave participants time to use what they had learned in practical applications in their own financial lives.

3.1) Session 1 – The Neurobiology of Financial Stress:

An introduction to the ways in which chronic financial stress negatively impacts cognition through neurobiological processes. This includes a detailed lay-language explanation of how the HPA-axis causes cortisol levels to be elevated under prolonged threat, resulting in the activation of the threat response centre, the amygdala. This process ultimately inhibits the function of the prefrontal cortex (PFC). The goal of this session is cognitive reattribution. Rather than seeing their financial cognitive issues as personal inadequacies, the participants' understanding of these issues was changed into one of modifiable environmental problems. Participants created a Personal Financial Stress Impact Map. This exercise consisted of a visualisation of the participant's major financial stressors and the corresponding negative cognitive and emotional impact.

3.2) Session 2 – Cognitive Reframing and Threat Appraisal:

Based on cognitive behavioural therapy (CBT; Beck et al., 1979) principles, this session focused on distinguishing between primary appraisals (the actual, objective financial state) and secondary appraisals (the catastrophic cognitive evaluation of that situation due to chronic stress of the amygdala-PFC system). Through facilitated group work, the participants determined their primary financial catastrophising thought patterns (all-or-nothing thinking, catastrophising, emotional reasoning) and attempted to construct an alternative evidence-based appraisal. In this session, the participants were linked back to the neurobiological explanation presented in the previous session by explaining that catastrophising is associated with increased cortisol production, hence decreasing PFC functioning.

3.3) Session 3 – Working Memory Limitations, Cognitive Load, and Financial Error:
This session delved into the connection between the limitations of working memory under stress and financial decision errors. Participants engaged in demonstrations of classical behavioural economic concepts such as present bias, amplification of loss aversion, representativeness heuristic, and sunk costs fallacy (Kahneman, 2011). The demonstrations were designed in such a way as to create personal connections for each participant. Digit span memory training exercises were modified to apply directly to financial decision-making contexts. The participants became more aware of their own cognitive biases, creating a basis for the counter-biasing interventions in following sessions.

3.4) Session 4 – Applied Financial Engineering Techniques:
Three types of financial decision-making tools were explained to participants, and they applied them to their own finances: (a) the debt avalanche method – paying down debts in order based on descending interest rate, in a manner that minimises interest payments, by completing a personal debt assessment and creating a debt repayment schedule; (b) opportunity cost analysis – an analytical tool that consists of two stages and involves explicitly determining the best alternative prior to any major financial decision; and (c) commitment devices – setting up pre-committed standing orders and automatic payments that reduce high-cognitive-load decisions during actual execution, in accordance with the nudge theory framework (Thaler & Sunstein, 2008).

3.5) Session 5 – Personalised Decision-Making Tools and Stress Response Planning:
In this session, the participants designed their personal Financial Decision Protocols (FDPs) that consisted of a structured ‘if… then…’ decision-making process, which allows for immediate action in situations of high stress and anxiety, based on implementation intention theory (Gollwitzer, 1999) and the principle of pre-commitment. This session additionally introduced two types of physiological techniques that could be used in acute stress response situations: extended exhalation breathing and brief progressive muscle relaxation. These techniques were linked back to the neurobiological explanation offered in Session 1 regarding the role of cortisol in inhibiting PFC functioning.

3.6) Session 6 – Integration, Reflection, and Future Planning:

In this session, the participants reflect on their overall progress during the whole course of the intervention. Based on a facilitator-led written reflection template, participants document the following: (a) cognitive changes that have occurred since Session 1; (b) examples of successful financial decision-making during the intervention; (c) ongoing problems and plans for future solutions; and (d) their financial future plan, including financial goals and milestones for the next twelve months.

4. Findings & Outcomes

4.1 Quantitative Findings

Table 2 presents pre- and post-intervention means, standard deviations, t-statistics, and effect sizes for all four outcome measures. All four showed statistically significant pre-to-post change, with effect sizes ranging from d = 0.84 to d = 1.31. All 95% confidence intervals for d exclude zero, indicating that, within this sample, the probability of a zero or negative true effect is small. Readers should nevertheless bear in mind the absence of a control group and the multiple comparison issue noted in Section 2.4: these findings are best treated as hypothesis-generating rather than confirmatory.

Table 2. Pre- and Post-Intervention Outcome Data (N = 15)

Measure	Pre-Intervention M (SD)	Post-Intervention M (SD)	t(14)	p	Cohen's d [95% CI]
Executive Function Score (0–100)	53.8 (9.2)	62.4 (8.1)	3.84	.002	0.99 [0.38, 1.59]
Financial Anxiety Scale (0–21)	14.9 (3.0)	11.2 (3.3)	4.18	.001	1.18 [0.52, 1.83]
Financial Decision Quality (%)	46.7 (11.8)	61.3 (10.4)	4.63	<.001	1.31 [0.60, 2.00]
Working Memory Accuracy (%)	63.1 (8.4)	69.8 (7.6)	3.12	.008	0.84 [0.25, 1.42]

Note: *Cohen's d computed as (Mpost − Mpre) / SDpooled (Cohen, 1988). 95% CIs via non-central t distribution. All Shapiro-Wilk tests p > .05. Bonferroni-adjusted threshold: α = .0125; all four outcomes meet this threshold.*

Executive Function: Scores on the composite measure of executive function improved significantly from M = 53.8 (SD = 9.2) to M = 62.4 (SD = 8.1; t(14) = 3.84, p = .002, d = 0.99; 95% CI [0.38, 1.59]). Fourteen of the 15 participants showed improvement, while one did not improve at all; no participants deteriorated. Positive contributions to the composite score came from both the Stroop Color-Word Test interference condition, which measures cognitive inhibition, and Trail Making Test Part B, which measures set-shifting (Stroop, 1935).

Financial Anxiety: Significant decreases were observed in FAS scores from M = 14.9 (SD = 3.0) to M = 11.2 (SD = 3.3; t(14) = 4.18, p = .001, d = 1.18; 95% CI [0.52, 1.83]). Specifically, nine out of fifteen participants showed changes in clinical severity levels for financial anxiety, moving either from severe anxiety to moderate anxiety or from moderate anxiety to mild anxiety. No formal assessment of participants' objective financial circumstances was conducted during the intervention period, and no such improvement was claimed or facilitated by the NLI. The observed reduction in self-reported financial anxiety is therefore interpreted as reflecting a shift in cognitive appraisal of the financial situation — consistent with the cognitive reframing emphasis of Sessions 1 and 2 — rather than any material change in underlying financial conditions. This interpretation, while theoretically coherent, cannot be empirically verified from the present data alone.

Financial Decision Quality: Pre-test to post-test change in FDSQ scores ranged from M = 46.7% (SD = 11.8%) to M = 61.3% (SD = 10.4%), t(14) = 4.63, p < .001, d = 1.31, 95% CI [0.60, 2.00]. The pre-test mean of 46.7% is notable in that, while above the theoretical chance level for a three-option format (chance = 33.3%), it remains substantially below what would be expected of participants making considered, informed choices, and is consistent with meaningfully degraded financial decision quality under conditions of high financial anxiety. In view of the heterogeneity of participants' disciplines — not all participants being enrolled in finance and financial engineering programs — this result cannot provide any evidence regarding domain-

knowledge independence. In the earlier version of the paper, the pre-intervention score level was interpreted as surprising "among financial engineering students"; this was incorrect and has been revised. As participants came from multiple disciplinary backgrounds and not exclusively from finance or financial engineering programmes, no inference about domain-knowledge independence can be drawn from this finding, and sub-group analysis is not possible at N = 15. Item type analysis revealed the largest improvements on present bias questions (M = 24.3%) and loss aversion questions (M = 21.7%) consistent with the counterbalancing exercises performed during Session 3 and Session 4.

Working Memory: Accuracy on simple memory span task improved significantly from M = 63.1% (SD = 8.4%) to M = 69.8% (SD = 7.6%; t(14) = 3.12, p = .008, d = 0.84; 95% CI [0.25, 1.42]). The relatively modest improvement on this measure compared to other outcome variables is in line with the theory: working memory enhancement occurs through increased bandwidth due to reductions in mental preoccupation, an indirect effect that should produce less magnitude of gains than the effects of direct practice in targeted intervention areas.

4.2 Qualitative Findings

Thematic analysis of participant reflective journals (n=105, 15 participants, 7 timepoints) and facilitator observation logs identified four major themes, which are presented below with illustrative quotations (participants anonymized using numerical codes).

Theme 1 – Cognitive Shift Toward Neurological Explanation and Cognitive Liberation: The most consistent and powerful qualitative change reported by participant journals across multiple sessions was a complete re-framing of the perceived source of any cognitive difficulties associated with personal financial management. This reattribution moved from a self-perception of financial

incompetence, internalized as a failure on the part of the individual, to an understanding of a biologically rooted form of impairment, created environmentally through excessive levels of stress. This cognitive shift was triggered in all cases during Session 1, and was reported by participants to happen quickly and with profound emotional significance.

Participant 7: "For three years I have been operating under the assumption that I was simply inept at handling my finances. Learning that stress is physically and biologically impairing my cognitive capacity to do so – that my difficulties are the result of chemistry, not character – was the most crucial realization I have had during my entire time at this university." Participant 2: "I had always viewed my tendency to avoid as a matter of personality. Realizing it is a natural stress response, and that there are things I can do to address it, has been transformative." Observations by facilitators indicated a shift in language patterns among group members after Session 1, from shamed, despairing, and self-deprecating towards biologically-grounded descriptions of a modifiable state. This pattern held and evolved over the course of subsequent sessions.

Theme 2 – Differentiating Objective Threat from Catastrophized Perception: The second prevalent theme involved learning how to distinguish objectively between the factual circumstances of a participant's finances and their subjective catastrophisation of those circumstances. Prior to participating in the intervention, journals tended to conflate these two dimensions; descriptions of financial status were uniformly phrased in absolute, worst-case, future tense terms, effectively dissolving the boundary between present reality and imagined, impending doom.

Following Session 2, journal entries increasingly made distinctions consistent with the theoretical explanation provided in the session itself. Participant 3: "I know there is debt. But what my brain is doing when it tells me that debt represents what will happen in my financial future – that part of what it is doing is not real." Participant 11: "I was

always basing my decision-making on my brain's projection of the future rather than my actual situation. And the two things are quite different." This ability to mentally disentangle these two aspects of the problem, and to recognize the role played by catastrophic thinking, was correlated with participants reporting reductions in negative affectivity regarding their finances, as well as increased readiness to engage proactively with financial data and decision-making.

Theme 3 – Structured Agency Using Applied Financial Engineering Strategies: Participants' journals reflected a qualitative shift, triggered by the introduction of tools for financial engineering in Sessions 3 and 4, from passively enduring financial stress to actively engaging in a structured process of problem-solving. In particular, the application of debt avalanche strategy led to a reframing of debt as an organized, rather than chaotic, series of tasks.

Participant 9: "Prior to Session 4 I would look at all seven debts that I had accrued and think of them only as a huge cloud. Since Session 4, I look at seven debts with associated interest rates and an action plan." In several cases, participants independently linked this reframing to cognitive load: it was not that they lacked the motivation to manage their debts, but rather that the process of doing so had become so cognitively demanding under chronic conditions of stress that they could not engage in it.

Participant 4: "Of course, logically I understood I should prioritize debts based on highest interest rate. Knowing this and following a system that enables me to do it are very different when you are stressed."

Theme 4 – Prospective Agency – From Avoidance to Goal-Directed Decision-Making: This final theme, which was prevalent in Session 5 and 6 journals and facilitator observations, related to a profound change in participants' temporal

perspective with regards to their finances, shifting from avoidance of present threats to future-oriented planning and decision-making. Journal entries prior to Session 1 focused almost exclusively on immediate sources of stress; by Session 5 and 6, they described a set of clearly formulated 1-year plans, 1-month milestones, and contingency strategies.

Participant 11: "Until I participated in this programme, the prospect of thinking about my financial future seemed impossible – too scary. But now I leave with a concrete plan and genuine confidence that I will find myself in a very different position 12 months down the line." Facilitator observation notes from Sessions 5 and 6 revealed changes in group dynamic; from substantial facilitator-led scaffolding required in earlier sessions, peer-to-peer discussion, collaboration, and mutual accountability were evident in the absence of such prompts

5. Reflections & Implications for Practice

5.1 Reflections on the Intervention

The Cycle 1 findings are provisionally encouraging. Pre-to-post improvements across all four outcomes, with large effect sizes and 95% confidence intervals that excluded zero, are consistent with the proposition that a structured intervention targeting both the cognitive and anxiety dimensions of financial stress may produce meaningful change within one academic semester. These results are interpreted as supportive of the theoretical model: if interventions reduce the chronic threat response, they may alleviate stress-driven limitations on prefrontal cortex functioning, producing improvements in executive performance, decision quality, and self-reported anxiety (Arnsten, 2015). However, causal attribution is not warranted at this stage given the absence of a control condition, as discussed in Section 5.2. Critically, the planned

Cycle 2 — incorporating a randomised waitlist control group, salivary cortisol sampling at baseline, mid-point and follow-up, neuroimaging where feasible, a larger sample, and longitudinal assessment at 3, 6, and 12 months — is designed specifically to address these interpretive constraints, and represents a genuine methodological progression from the present pilot. Effect sizes obtained for the reduction of financial anxiety (d = 1.18) correspond with benchmark values for properly designed CBT-based interventions for anxiety (d = 0.80-1.20; Hofmann et al., 2012).

The improvement in financial decision quality (d = 1.31) is particularly striking given the multi-disciplinary composition of the sample. A pre-test score of 46.7% — above the theoretical chance level of 33.3% for a three-option format, yet substantially below what informed decision-making would produce — suggests that high financial anxiety meaningfully degrades financial decision performance at baseline. Whether this degradation reflects primarily cognitive or anxiety-based mechanisms cannot be determined from the present data; Cycle 2, incorporating cortisol measurement and active control conditions, is needed to disentangle these pathways.

The working memory improvement (d = 0.84), smaller than the other effects, is theoretically interpretable as a distal rather than direct outcome of the intervention, arising through reduced cognitive preoccupation (bandwidth release) and lower decision load following the financial engineering sessions rather than through targeted memory training.

The qualitative data provide complementary evidence of process: the four themes document coherent mechanisms — cognitive reattribution, threat appraisal differentiation, structured agency, and prospective orientation — that correspond to the session content and are consistent with CBT-based accounts of anxiety reduction. Importantly, these narrative accounts corroborate the quantitative picture without being reducible to it.

5.2 Limitations & Honest Reflections

Several limitations constrain the conclusions that can be drawn from Cycle 1 findings, and these are reported here without mitigation.

First and most critically, the absence of a control condition means that the observed changes cannot be attributed to the NLI itself. Alternative explanations include natural semester-level variation in stress, non-specific social support effects from the group experience, and simple maturation.

Second, regression to the mean represents a plausible partial explanation for the observed FAS reduction. Participants were selected on the basis of elevated FAS scores (≥ 10), and individuals selected at the high end of a distribution tend to score somewhat lower on re-measurement regardless of intervention, due to measurement error and distributional properties (Cohen, 1988). This threat is particularly acute for the financial anxiety outcome and cannot be ruled out without a matched control group.

Third, practice effects represent a competing explanation for the cognitive gains. The Stroop Color-Word Test and Trail Making Test Part B were administered using identical stimulus forms at both time points; alternate forms were not used. Familiarity with task stimuli and format on re-administration may have independently produced performance improvements irrespective of any change in underlying cognitive capacity.

Fourth, the limited sample size of 15 participants reduces the generalisability of the findings and makes any subgroup analysis inappropriate.

Fifth, the dual role of researcher as facilitator and data analyst introduces potential bias, only partially mitigated by the blinded inter-rater reliability procedure for qualitative coding.

Sixth, no objective measurement of cortisol levels was conducted; the HPA-axis account of the observed changes remains a theoretical interpretation rather than a verified mechanism.

Seventh, the sustainability of effects beyond Week 12 is unknown.

Eighth, three participants dropped out of the programme (attrition rate: 16.7%).

These limitations define the priority agenda for Cycle 2: a randomised waitlist control design; larger sample; salivary cortisol measurement at baseline, mid-point, and follow-up; neuroimaging where feasible; longitudinal follow-up at 3, 6, and 12 months; member-checking; and intention-to-treat analysis. Each limitation is treated not as a methodological failure but as structured input for the design of the next cycle (Schön, 1983).

5.3 Implications for Practice

The findings of Cycle 1 are hypothesis-generating and should not be taken as sufficient evidence for immediate widespread practice change. They are, however, promising enough to warrant the following tentative recommendations, each of which requires testing in more rigorously controlled settings before adoption as institutional policy.

Consider supplementing information-based student financial support with anxiety and cognition-focused components. The Cycle 1 results are consistent with the proposition that financial information delivered to severely anxious students may be difficult to utilise, and that addressing anxiety and cognitive load first may increase the effectiveness of subsequent informational support. This hypothesis warrants testing in a controlled design.

Pilot neuropsychoeducational reattribution as a brief stand-alone element. The cognitive reattribution component of Session 1 — shifting attributions of financial cognitive difficulty from character to modifiable state — appeared, in the qualitative data, to produce rapid and valued change. Delivering this element as a brief addition to student financial orientation programmes would be low cost and could be evaluated with minimal resources. Whether it produces durable benefits without the full NLI remains to be established.

Explore whether applied financial engineering content adds value when integrated into student support. The structured financial tools introduced in Sessions 3 and 4 appear to have contributed to the sense of structured agency documented in Theme 3. Whether this contribution is specific to the NLI context or replicable in stand-alone financial skills training is an empirical question for future comparative studies.

5.4 Future Research Directions

Cycle 2 priorities are as described in Section 5.2. Beyond that, the following directions are indicated by the present study. Neurobiological investigation — pre-post assessment of PFC activation, amygdala reactivity, and working memory network connectivity — would provide direct evidence for the theoretical mechanisms proposed. Comparative effectiveness studies contrasting the NLI with standard financial literacy training would address the specificity of the effect. Studies applying the NLI in populations with domain-specific financial knowledge (financial engineering, economics, or quantitative finance programmes) would allow a more controlled examination of whether observed decision quality gains are independent of prior domain knowledge. Longitudinal designs would assess whether cognitive and anxiety improvements translate into durable changes in financial behaviour.

Declarations

Conflicts of Interest: The author has declared no conflicts of interest.

Ethical Statement: The study was conducted in accordance with the ethical standards of the host institution. Participants' anonymity was ensured throughout the process. There was no acquisition of personal data by the researcher. Consent forms were provided to all participants. Participants were informed about their right to withdraw from the research at any time.

AI Use Disclosure: The language editing, grammar, and formatting technologies were used in writing this paper. However, no help was received in designing the study, collecting and analysing data, or building the theoretical argument.

Appendix A:

Financial Decision Scenarios Questionnaire (FDSQ) — Item Outlines

The 20-item FDSQ was constructed by the researcher. Each item presents a financial decision scenario with three labelled options; one is designated optimal by expected value and net present value criteria, and two exploit known cognitive biases. The bias-type coverage is as follows: present bias (5 items), loss aversion amplification (5 items), representativeness heuristic (5 items), and sunk cost fallacy (5 items). Full item texts are available on request from the corresponding author pending any journal data-sharing requirements. The in-sample internal consistency of $\alpha = .71$, while meeting conventional thresholds (Nunnally, 1978), reflects the intentional heterogeneity of bias types within the scale; high item-intercorrelations would not be expected across conceptually distinct bias categories. Readers are cautioned against treating α as an index of construct-level homogeneity in this context.

References

Archuleta, K. L., Dale, A., & Spann, S. M. (2013). College students and financial distress: Exploring debt, financial satisfaction, and financial anxiety. Journal of Financial Counseling and Planning, 24(1), 50–62.

Arnsten, A. F. T. (2015). Stress weakens prefrontal networks: Molecular insults to higher cognition. Nature Neuroscience, 18(10), 1376–1385. https://doi.org/10.1038/nn.4087

Beck, A. T., Rush, A. J., Shaw, B. F., & Emery, G. (1979). Cognitive therapy of depression. Guilford Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

British Psychological Society. (2021). Code of ethics and conduct. BPS.

Camerer, C., Loewenstein, G., & Prelec, D. (2005). Neuroeconomics: How neuroscience can inform economics. Journal of Economic Literature, 43(1), 9–64. https://doi.org/10.1257/0022051053737843

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE.

Gathergood, J. (2012). Self-control, financial literacy and consumer over-indebtedness. Journal of Economic Psychology, 33(3), 590–602. https://doi.org/10.1016/j.joep.2011.11.006

Golden, C. J. (1978). Stroop Color and Word Test: A manual for clinical and experimental uses. Stoelting.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. American Psychologist, 54(7), 493–503. https://doi.org/10.1037/0003-066X.54.7.493

Hofmann, S. G., Asnaani, A., Vonk, I. J. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of cognitive behavioral therapy: A review of meta-analyses. Cognitive Therapy and Research, 36(5), 427–440. https://doi.org/10.1007/s10608-012-9476-1

Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux.

Kemmis, S., & McTaggart, R. (2005). Participatory action research. In N. K. Denzin & Y. S. Lincoln (Eds.), The SAGE handbook of qualitative research (3rd ed., pp. 559–603). SAGE.

Knutson, B., & Bossaerts, P. (2007). Neural antecedents of financial decisions. Journal of Neuroscience, 27(31), 8174–8177. https://doi.org/10.1523/JNEUROSCI.1564-07.2007

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. Biometrics, 33(1), 159–174. https://doi.org/10.2307/2529310

Lupien, S. J., McEwen, B. S., Gunnar, M. R., & Heim, C. (2009). Effects of stress throughout the lifespan on the brain, behaviour and cognition. Nature Reviews Neuroscience, 10(6), 434–445. https://doi.org/10.1038/nrn2639

Lusardi, A., & Mitchell, O. S. (2014). The economic importance of financial literacy. Journal of Economic Literature, 52(1), 5–44. https://doi.org/10.1257/jel.52.1.5

Mani, A., Mullainathan, S., Shafir, E., & Zhao, J. (2013). Poverty impedes cognitive function. Science, 341(6149), 976–980. https://doi.org/10.1126/science.1238041

McNiff, J. (2017). Action research: All you need to know. SAGE.

Mullainathan, S., & Shafir, E. (2013). Scarcity: Why having too little means so much. Times Books.

Norvilitis, J. M., & Mao, Y. (2013). Attitudes towards credit and finances among college students in China and the United States. International Journal of Psychology, 48(3), 389–398. https://doi.org/10.1080/00207594.2011.645486

Nunnally, J. C. (1978). Psychometric theory (2nd ed.). McGraw-Hill.

Reitan, R. M. (1958). Validity of the Trail Making Test as an indicator of organic brain damage. Perceptual and Motor Skills, 8(3), 271–276. https://doi.org/10.2466/pms.1958.8.3.271

Richardson, T., Elliott, P., & Roberts, R. (2013). The relationship between personal unsecured debt and mental and physical health. Clinical Psychology Review, 33(8), 1148–1162. https://doi.org/10.1016/j.cpr.2013.08.009

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. Basic Books.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. Journal of Experimental Psychology, 18(6), 643–662. https://doi.org/10.1037/h0054651

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

Thaler, R. H., & Sunstein, C. R. (2008). Nudge: Improving decisions about health, wealth, and happiness. Yale University Press.

Wechsler, D. (2008). Wechsler Adult Intelligence Scale — Fourth Edition (WAIS-IV): Administration and scoring manual. Pearson.

World Medical Association. (2013). Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA, 310(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053