Development of a Thai Lexical Decision Task as a Tool for Premorbid Estimation of Cognitive Function

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Abstract

Background: In psychiatric and neurological evaluations, the estimation of premorbid ability is used to distinguish baseline functioning from acquired cognitive impairment. Premorbid estimation can be achieved with 'hold' tasks. Such hold tasks, which resist decline after neurological injury, are commonly used to estimate premorbid ability. In contrast, 'no hold' tasks depend on fluid processing, particularly executive functioning, and are substantially more susceptible to impairment. Several hold tests exist in English, all based on measuring acquired vocabulary. However, none is available in Thai.

Objective: To determine if a Thai-language lexical decision task can function as a hold test for clinical cognitive assessment, addressing the current lack of such tools in Thai.

Materials and Methods: The research was cross-sectional. A non-clinical opportunity sample of 104 university students was assessed with the Thai Lexical Decision Task (a putative hold task) and two measures of executive functioning (no hold tasks): the Color Trails Test and the Choice Trails Test. All participants also completed the Hospital Anxiety and Depression Scale, a self-report psychological distress questionnaire.

Results: Higher psychological distress, including anxiety and depression, was significantly correlated with slower performance on the executive function tests, $r=0.18$ to 0.38, $p<0.05$ (zero-order and partial correlations controlling for gender), indicating their no hold status. However, the recently developed Thai Lexical Decision Task showed no significant associations with psychological distress variables, $r=-0.03$ to 0.04, $p>0.50$, suggesting that it is resistant to anxiety and depression. Similar findings were observed when comparing probable clinical cases who were psychologically distressed to emotionally well participants.

Conclusion: This study demonstrates a dissociation between fluid and crystalized cognitive ability in the presence of psychological distress. The results support the Thai Lexical Decision Task as a potential hold test for estimating premorbid cognitive function in Thai as part of clinical assessments.

Keywords: Cognitive assessment; Premorbid functioning; Crystallized intelligence; Executive function; Neuropsychological tests

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Cognitive impairments, side effects, risk factors, etc., are found in the majority of disorders seen by psychiatrists, neurologists, and even endocrinologists[(1)]. Consequently, cognitive assessment is an integral part of clinical examination in various contexts. In particular, estimating premorbid ability, the level of cognitive functioning prior to the onset of illness, is necessary for understanding the magnitude of cognitive impairments. This is typically performed by estimating

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What is already known about this topic?

Executive cognitive function impairments are frequently observed across neurological and psychiatric disorders, representing a trans-diagnostic feature of disease affecting the brain. In contrast, lexical-reading task performance is generally preserved in most disorders, including individuals with psychiatric signs and symptoms, and even mild dementia. Capitalizing on that performance dissociation, standardized neuropsychological assessment tools, such as the National Adult Reading Test and Spot-the-Word Test, are widely used in English-speaking countries to estimate premorbid cognitive ability in clinical cognitive assessments.

What does this study add?

This study is the first to develop and initially validate a culturally-adapted Thai Lexical Decision Task for clinical use, specifically, supporting its use as a tool to estimate premorbid cognitive ability in Thai populations. It also supports the dissociation between impaired executive functioning and preserved lexical performance in individuals with psychological distress, suggesting new applications for cognitive assessment and research in Thai-speaking and other global populations.

a patient's premorbid IQ. This is because IQ gives an overall idea of an individual's cognitive ability. Then, their current cognitive test performance can be compared to that estimated at the premorbid level.

Without such estimates, true declines in cognitive ability and previously normal levels of functioning are challenging to disambiguate. Many clinical bodies and sources recommend the assessment of premorbid function. The American Congress of Rehabilitation Medicine[2] emphasizes assessment of premorbid ability in the management of traumatic brain injury. Similarly, Hutchinson's Clinical Science emphasizes the need for premorbid ability measures when assessing older patients[3]. That also highlights its importance in evaluating conditions such as dementia.

Many such tests are already in widespread use by neuropsychologists and other clinical neuroscientists. The tests are known as 'hold' tests because they are often not sensitive to neurological or psychiatric disorders. This means that the level of task performance observed post-morbidly will be similar to what it was premorbidly. Nevertheless, as with many cognitive assessment tools, there are cultural barriers to their use. Specifically, existing assessments of premorbid cognitive function rely on measuring knowledge or wordforms. They are therefore only useful within the linguistic cultures within which they were developed.

These premorbid hold tests include the commercially produced National Adult Reading Test[4] and the Test of Premorbid Functioning[5]. The rationale of such assessment methods is to measure performance on cognitive tests that show differential sensitivity to disorders affecting brain functioning. If scores on tests that are not sensitive to impairment are compared with scores on tests that are highly sensitive, then the relative difference in performance is indicative of the level of change in ability. As an example, the Speed and Capacity of Language Processing Test (SCOLP)[6] uses a lexical-decision task. Performance on that is compared to performance on a timed sentence-verification task. Scores on the lexical-decision aspect have been shown to be not sensitive to depression and anxiety[7], and even to mild to moderate Alzheimer's disease[8]. In contrast, the timed sentence verification task is highly sensitive to not only dementia[9] but also a range of psychiatric disorders, including bipolar depression[10], thought disorder[11], and memory problems[12] in people with schizophrenia.

Accurate assessment of cognitive decline or impairment, therefore, involves comparing performance on tasks sensitive to cognitive impairment or decline with those resistant to change. For example, to assess bradyphrenia (slowing of thought processes)[13] in a patient, the clinician could use the sentence verification task of the SCOLP[6] to assess actual speed of processing. The clinician could then also estimate how fast the patient should be able to perform, if unimpaired, based on the lexical-decision task performance. If the actual observed speed of performance is substantially below the estimated premorbid performance, bradyphrenia could be suspected.

The stable tasks, often referred to as hold tasks (i.e., tasks generally unaffected by brain-related disorders)[8,14,15], rely on language-based, crystallized cognitive ability, such as lexical-decision tasks. Although several studies have supported the observation that performance often holds in mild dementia, of course, they are not appropriate for language-based dementia variants, such as primary progressive aphasia[16].

In contrast, no-hold tasks rely on 'fluid' cognitive processing. Such tasks involve dynamic, rapid, cognitive processing, including problem-solving and decision-making, particularly tests of executive function. These are very susceptible to decline or impairment as sequelae of neurological[17] and psychiatric disorders[18-20]. A task that exemplifies executive function is the Color Trails Test[21]. It is completed as a bedside pen and paper task in which the participant must draw lines connecting circles on a page. The executive component comes from a task requirement that the participant must repeatedly switch between connecting pink and yellow circles. A related test is the Choice Trails Test[22], which has a similar format but requires the participant to choose circles as randomly as possible, further demanding divergent-executive control[23].

Because hold tasks rely on crystallized ability, which is often measured by vocabulary, tests based on these tasks are ineffective when used in different languages or cultures. This study aims to investigate the use of a cognitive assessment tool that could potentially estimate premorbid cognitive functioning in the Thai language. This is because presently, no methods exist for formal cognitive estimation of premorbid function in the country.

Although various methods of measuring crystalized ability for premorbid assessment have been proposed, lexical decision has several advantages over other methods. These include objective scoring, high patient tolerability, and task performance that is not directly limited by dysarthria or anomia[15,16], which are common neurological symptoms. Importantly, lexical decision tasks have been used across multiple languages

as measures of crystallized lexical knowledge that reflect premorbid cognitive ability, with performance shown to be relatively preserved in the presence of neurological or psychiatric conditions, supporting their suitability as hold measures.

We have developed such a test, basing it on the English-language Spot-the-Word Test[6,7]. This test, the Thai Lexical Decision Task, contains 42 items and has a good internal consistency (α=0.88), test-retest reliability (r=0.92), and validity as measured by associations with linguistic variables[24]. However, further research is needed to establish its use in clinical cognitive assessments.

As a first step, it is essential to show that a potential test holds in the presence of a psychiatric or neurological disorder despite impaired cognitive performance being demonstrable with a different no-hold test. We examined such a relative discrepancy between hold and no-hold tests in relation to mood disorder, specifically symptoms of anxiety and depression. Anxiety and depression symptoms were used as these have previously been shown not to influence lexical-decision task performance in English[7] but are nevertheless associated with reduced executive function task performance[18-20]. In addition, the relatively high prevalence of anxiety and depression, and their spectrum nature, allowed us to include participants with a reasonably wide range of symptom severity.

In this study, we assessed cognitive performance using the Trail-making tests and a lexical decision task, hypothesizing that the former would be sensitive to, and the latter relatively resistant to, the effects of depression and anxiety symptoms. The data and scores on self-reported psychological distress were collected from a non-clinical, opportunity sample of undergraduate students at Chulalongkorn University. Psychological distress (i.e., symptoms of anxiety and depression) was chosen because of its established links to suppression of cognitive test performance[18-20]. Students were sampled as they are known to have a relatively high prevalence of anxiety and depression, yet are fairly homogenous regarding potentially confounding variables, such as age and socioeconomic background.

In summary, the cognitive impairments associated with clinical depression and anxiety are also observed in those who would not necessarily meet criteria for diagnosis, but are nevertheless experiencing psychological distress[25]. Consequently, such people would be expected to show a dissociation between no-hold and hold cognitive tasks. We tested our hypotheses on a sample expected to have such subclinical symptomology. Our research question was focused on whether a student sample would demonstrate associations between psychological distress and non-hold executive functions, despite no associations with a hold lexical-decision task. Specifically, we hypothesized that participants with higher psychological distress scores would show impaired performance on tests of executive functioning, but not on the Thai Lexical Decision Task. We anticipate that the results will reflect those in past research that used the English-language Spot-the-Word Test[6,7,26].

Materials and Methods

Participants

A minimum sample size of 92 participants was established to have sufficient power to detect correlations with a false positive error rate at 0.1, one-tailed with alpha set to 0.05[27]. To be sure of sufficient power, we oversampled, recruiting a total of 104 participants. All were undergraduate Thai students from the Faculty of Psychology, Chulalongkorn University, Bangkok, and were recruited via opportunity sampling. Inclusion criteria were that they were Thai speakers without sensory or motor disability. The sample was chosen as a convenience sample. All 104 participants completed the assessments. Although they were psychology students, the participants were not informed of the expected results beforehand. Regarding gender, 26/104 (25%) were male, 77/104 (74%) were female, and 1/104 identified as other gender. The mean age of the participants was 20.4 years (SD 1.3).

This study was approved by the Chulalongkorn University Institutional Review Board (071/67). All participants provided informed consent prior to participation. The study involved a non-clinical population of university students and did not include any clinical or interventional procedures. Therefore, clinical trial registration is not applicable.

Procedure

Participants were recruited via social media advertisements. Upon contact, the research was explained to them by a research assistant, and they provided written informed consent to continue, in accordance with the IRB-approved research protocol (071/67). All were assessed individually, in one-to-one assessments with the research assistant in a private room on the university campus. Data collection was performed between March 2024 and February 2025. Participants were paid 100 Baht for their time (approximately US$3). All participants were assessed

with the measures described below.

Hospital Anxiety and Depression Scale

Participants were asked to complete the Hospital Anxiety and Depression Scale (HADS), a self-report questionnaire[28]. This contains 14 items, 7 of which focus on depressive symptoms, and the other 7 on anxiety-related symptoms. Each item is scored on a Likert scale. Total scores are calculated by the summation of all items. A validated Thai-language version was used[29]. Each subscale (depression/anxiety) yields a continuous score ranging from 0 to 21. Within the current sample, the reliability of the Anxiety subscale had a Cronbach's α of 0.80 while the Depression subscale had a Cronbach's α of 0.70, aligning with the findings of Lueboonthavatchai[30] in a different Thai sample. Although HADS scores are often used as continuous variables to indicate the magnitude of symptoms, cutoff scores have been established that allow the identification of probable cases of clinically diagnosable disorder, with scores of 11 or higher indicating probable cases of anxiety[29,30] and similarly 11 or higher for depression. Those scoring at or below 7 on both the Anxiety and Depression subscales are considered euthymic, with scores in between considered possible/ambiguous or doubtful cases[30,31].

Thai Lexical Decision Task

The Thai Lexical Decision Task[24], used in this study, was modelled on the English-language Spot-the-Word Test[6]. The Thai Lexical Decision Task involves a simple paper-and-pencil word recognition task. It has a total of 42 items composed of word pairs. Within each pair, one word is a real, though low-frequency word in Thai, and the other word is a pseudoword that does not have a meaning in the Thai language but follows conventions for combining Thai characters and thus appears legitimate. The participants are required to identify and circle the real Thai word within each pair. The real and pseudowords were selected from a larger sample after factor analysis of the responses from 662 Thai adults. The test has also demonstrated validity and reliability with Thai samples[25]. The data recorded is simply correct or incorrect for each item (no response times are measured), one point is awarded for each correct answer, and a total score is derived by summation. The highest score, indicating perfect performance, is therefore 42. Using the data from the current sample, the Thai Lexical Decision Task internal consistency was estimated with KR-20 α of 0.89[32].

Color Trails Test

There are relatively few executive function tests with established psychometric properties for use in Thailand[33]. One exception is the Color Trails Test[21]. It is useful in the current context as it has been verified as psychometrically sound within Thailand, in terms of test-retest reliability[34]. Convergent validity has also been established in the Thai context, as the Color Trails Test is correlated (r=0.50) with a standard trail-making test[21]. In this test, participants are presented with a sheet containing numbered circles (1 to 24) in two alternating colors, pink and yellow. They are instructed to connect the numbers sequentially, ensuring that they alternate between the colors whilst maintaining the numerical order. This requires the use of executive control processes, particularly set shifting. The time taken to complete the task is recorded, with longer completion times indicating worse performance. Errors were not recorded. However, performance was monitored by the researcher, and when any errors occurred, the participant was required to return to the last correct point and continue from there, as the stopwatch continued to run, measuring completion time.

Choice Trails Test

The Choice Trails Test has a similar format to the Color Trails Test; however, it is altered to increase the cognitive load by introducing response choices. Thus, in addition to set shifting, this task increases task demands by introducing elements of divergent thinking[23]. This assessment tool has also been validated in Thailand[22]. Similar to the Color Trails Test, the Choice Trails Test requires participants to connect the numbers 1 to 24 in sequence. However, multiple instances of each number are presented in different colors, and participants must select a different color for each connection as they progress through the sequence. The participants are timed as they complete the task. The data of interest is the time to complete the task in seconds. A longer task completion time indicates worse performance. Errors were treated in the same way as for the Color Trails Test.

These measures of cognitive ability were selected as they are two of the few that have been validated for assessment of executive functions in Thai adult samples[21,22]. Both tasks require fluid cognitive processing and could be anticipated to be sensitive to psychiatric disorders[18-20]. Including two differing assessments has a benefit as it allows for greater coverage of executive control, increasing the validity of the measurement when combined. Nevertheless, the

Choice Trails Test involves random-response selection in addition to switching, which increases the cognitive load. That factor may make it more sensitive to the cognitive suppression associated with psychological distress[18-20].

Statistical Analyses

To analyze the association between pairs of continuous variables in which data distributions deviate from a normal distribution, an effective method of preventing false positive errors is a Rankit transformation combined with the Pearson correlation statistic[35,36]. This also provides optimal power for correlation confidence intervals[37]. Although often Spearman methods would be used, this transformation allows the use of parametric methods, potentially increasing statistical power. The transformation was performed on all continuous variables. In addition, probable cases of psychological distress were identified and compared to cases unlikely to be suffering anxiety or depression; these groups were compared with between-subjects t tests. As we are hypothesizing that impaired task performance would be associated with greater psychopathology, analyses were performed one-tailed. Although uncommon in some fields, one-tailed tests are preferred when measuring deficits, as the two-tailed alternative would needlessly increase the Type II error rate[38]. Because our hypotheses were specified a priori and directional, statistical analyses were conducted using one-tailed tests[39]. Specifically, greater psychological distress was hypothesized to be associated with poorer cognitive performance, whereas improvements in performance associated with higher distress were not theoretically expected. In neuropsychological research, one-tailed testing is commonly applied when evaluating hypothesized cognitive deficits rather than potential enhancements[40]. A threshold of 0.05 was used to determine statistical significance. No correction was made for multiple comparisons. We have used qualitative interpretations of correlation effect sizes, i.e., $r>0.1$ = 'small', $r>0.3$ = 'medium', and $r>0.5$ = 'large', and Cohen's $d>0.2$ = 'small', $d>0.5$ = 'medium' and $d>0.8$ = 'large', which are established norms[27].

Results

Initial Examination of Data and Analyses

All participants provided complete data. We first examined the associations between demographics and performance and psychological distress variables, as well as the correlations between closely related variables. These analyses were performed two-tailed. Age was not found to correlate significantly with any of the measures, all $r<0.19$, all $p>0.05$, which would be expected with a student sample that has a very narrow age range. However, gender was significantly correlated with several variables. Female participants, relative to male participants, performed significantly more slowly on both executive function tests (Color Trail Test: $r(101)=-0.28$, $p<0.01$ and Choice Trails Test: $r(101)=-0.23$, $p=0.02$), and also reported significantly higher levels of anxiety, $r(101)=0.25$, $p=0.01$, though the relationship to depression was not significant, $r(101)=0.18$, $p=08$.

A qualitatively 'large' positive correlation was established between the anxiety and depression subscale scores on the HADS, $r(102)=0.53$, $p<0.01$. This is consistent with previous studies, which suggest that although the HADS subscales measure anxiety and depression symptoms well, the scale overall functions better as a single measure of psychological distress[41,42]. For this reason, overall performance on the HADS was considered a measure of psychological distress, as well as the individual subscale scores of anxiety and depression. The use of the overall score is potentially more useful, as being based on responses to all 14 items, it would be expected to be a more reliable measure. To that end, the mean of standardized (z) scores from both subscales was used to form a composite.

We also examined the association between the two measures of executive function, the Color Trails Test and the Choice Trails Test. The mean scores on the two measures were similar: For the Color Trails Test, this was 64.24 (SD 17.45) seconds, and for the Choice Trails Test, 65.80 (SD 21.55) seconds, with similar coefficients of variance, 27% and 33%, respectively. These two measures of executive function also showed a 'large', significant, and positive correlation, $r(102)=0.57$, $p<0.01$. We also calculated an Executive Composite score by averaging the standardized (z) scores from the Color Trails Test and Choice Trails Test; for this composite, higher scores indicate worse executive function. Overall psychological distress was represented by averaging z-scores from the HADS anxiety and depression subscales, with higher scores indicating greater distress. The descriptive statistics from the different measures are summarized in Table 1.

Main Analyses

The first step in the main analyses aimed to address our hypotheses by examining whether psychological distress is associated with cognitive test performance using scores on the HADS as continuous

Table 1. Descriptive statistics for the sample demographics and different measures employed

Assessment	Measure	Mean (SD)	Range	Within clinical range; n (%)	Reliability α
Demographics	Age in years	20.42 (1.32)	17 to 23	-	-
	Semesters completed at university	3.94 (2.89)	1 to 7	-	-
HADS	Depression total score	4.09 (2.83)	0 to 12	6/104 (6%)[a]	0.70
	Anxiety total score	6.75 (3.5)	0 to 17	13/104 (13%)[a]	0.80
	Combined total score	10.80 (5.59)	2 to 27	16/104 (15%)[a,b]	0.83
Color Trails Test	Completion time in seconds	64.24 (17.45)	38 to 130	-	-
Choice Trails Test	Completion time in seconds	65.80 (21.55)	34 to 173	-	-
Thai Lexical Decision Task	Total accuracy	32.77 (6.88)	16 to 42	-	0.89

HADS=Hospital Anxiety and Depression Scale; SD=standard deviation
(a) Criterion for classifications using cutoff scores is described below, (b) Shows those classified as suffering psychological distress (described below)

Table 2. Pearson zero-order and partial (gender-controlled) correlation coefficients between HADS scores and cognitive assessments (n=104)

	Anxiety		Depression		Psychological distress	
	Zero-order	Partial	Zero-order	Partial	Zero-order	Partial
Color Trails Test	0.25**	0.33***	0.15	0.17*	0.25**	0.31***
Choice Trails Test	0.30***	0.36***	0.18*	0.19*	0.30***	0.35***
Executive Composite	0.29**	0.38***	0.18*	0.20*	0.29**	0.36***
Thai Lexical Decision Task	0.03	−0.02	0.04	0.03	0.03	−0.01

* p<0.05, ** p<0.01, *** p<0.001, All p-values calculated one-tailed

variables. The zero-order correlation coefficients are shown in Table 2. In addition, Table 2 is the partial correlations controlling for gender, as that is a potential confounding variable, given its correlations with anxiety and cognitive variables in the current sample. The table clearly shows a pattern of significant positive correlations between the executive function measures and HADS scores indexing psychological distress symptoms. The pattern of correlations is that all are in the direction of poorer executive function performance being associated with greater levels of psychological distress. The magnitude of the correlations corresponds to qualitatively 'small' and 'medium' effect sizes. In contrast, there is no observable correlation between the HADS scores and performance on the Thai Lexical Decision Task. In fact, the dissociation is statistically significant: the correlation r value of the association of Psychological Distress with the Executive Composite (r=0.36, 95% CI=0.17 to 0.52) is significantly higher than its association with Thai Lexical Decision Task scores (r=–0.01, 95% CI –0.23 to 0.22), based on the difference in r values, of z=2.61, p<0.001. As the correlations reported in Table 2 were conducted on transformed data, we repeated the analyses with untransformed figures using Spearman (non-parametric) methods. The overall pattern of significant and non-significant effects was mainly unchanged.

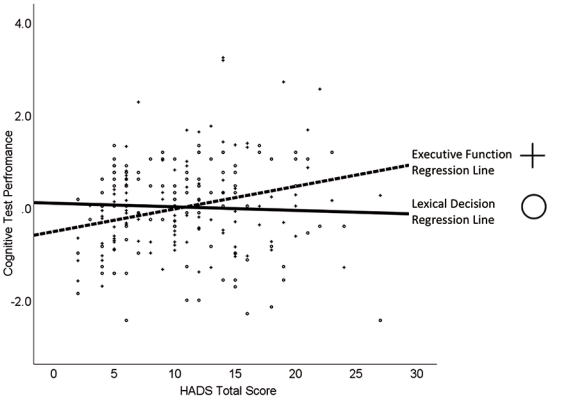

Figure 1. Scatterplot showing executive composite (+) and lexical decision task (○) z scores plotted against psychological distress scores on the Hospital Anxiety and Depression Scale.

However, two correlations (Depression with Choice Trails Test, and Depression with Executive Composite) both dropped from r=0.18 to r=0.15, and were no longer significant in the zero-order analyses, though they remained significant in the partial correlations.

A scattergram illustrating the relationship between HADS total scores and cognitive measures is shown in Figure 1, which includes regression lines. Raw scores on the cognitive measures were standardized into z scores, and the total HADS score is used as the measure

Table 3. Comparison of the emotionally well and psychologically-distressed subgroups on the cognitive assessments

Measure	Mean (SD)		Sig.	Effect size (d)
	Emotionally-well (n=60)	Psychologically distressed (n=16)		
Color Trails Test[a]	62.16 (15.89)	72.65 (23.23)	t(74)=−2.02, p=0.02	0.57
Choice Trails Test[a]	61.6 (14.99)	73.54 (23.85)	t(74)=−1.89, p=0.03	0.53
Executive Composite[b]	−0.18 (0.79)	0.49 (1.22)	t(74)=−2.25, p=0.03	0.63
Thai Lexical Decision Task[c]	33.02 (6.28)	29.88 (8.97)	t(18.82)=0.92, p=0.19	0.32

SD=standard deviation

(a) Mean task completion time in seconds, (b) Composite made by summing z scores for completion time in both trail-making tasks, (c) Mean total accuracy

of psychological distress. This shows graphically how poorer executive function scores were associated with higher psychological distress, while there was no such association with lexical-decision scores, which produced a virtually flat regression line.

To summarize so far, the results based on HADS scores indicated that psychological distress is associated with worse performance on the fluid, executive function tasks, but not with the crystallized, lexical-decision task. However, from a clinical perspective, it is often more useful to identify individuals with psychological distress reaching probable clinical diagnosable levels. In the following analyses, cutoff scores were used to identify probable cases of depression and anxiety, and these were compared with those of individuals who were unambiguously not suffering from psychological distress.

The mean score for the whole group on the anxiety subscale was 6.75 (SD 3.50, range 0 to 17), which was somewhat higher than the mean score for depression, mean 4.09 (SD 2.83, range 0 to 12), a statistically significant difference, $t(103)=8.67$, $p<0.01$, $d=0.85$. A standard cutoff to identify probable clinical anxiety on the HADS is ≥11[29], which applied to 13/104 individuals (13%) in this sample (scores 11 to 17). The same cutoff identified only two probable cases of depression (<2%).

Examination of the data distribution of HADS Depression subscale scores showed evidence of bimodality around a cutoff score of 10. That is consistent with previous studies in Thailand that have suggested that a lower threshold for HADS depression scores is needed to identify cases in this culture[43,44]. In fact, in the original validation of the HADS in Thai, a cut-off of ≥10 actually had the best overall sensitivity and specificity[29]. With that threshold, 6/104 individuals were identified as probable cases of depression (6%), with a score range of 10 to 12. That is consistent with another study in Thailand that suggested that the prevalence of depression among Thai university students is >4%[45].

To identify groups of probable cases and non-cases, the 104 participants were categorized as those who were euthymic, i.e., no evidence of psychological distress (n=60), and those with probable psychological distress (n=16). Individuals who met the criteria as probable cases of anxiety, probable cases of depression, or both, were grouped under the probable psychological distress category. Proportions of participants classified as suffering anxiety, depression, and psychological distress are summarized in Table 1. Participants who scored in the midrange, being only possible for either or both anxiety and depression, but did not meet the criteria for probable disorder (n=28), were not included in the analyses, as these are ambiguous as to mental health status. These groups were then compared on the various cognitive measures. The results are shown in Table 3.

Summarizing the data in the table, on the Thai Lexical Decision Task, the mean score for the emotionally well group was slightly higher than the distressed group. However, the difference was not statistically significant. This suggests that psychological distress had not influenced task performance. Meanwhile, on the Color Trails Test, the emotionally well group performed the task over ten seconds faster than the distressed group. That difference was statistically significant. The medium effect suggests that psychological distress may be linked to slower executive function performance in students. A similar, and slightly larger effect was found with the Choice Trails Test, where the emotionally well group took significantly less time to complete the task compared to the distressed group. Unsurprisingly, a similar effect was shown when analyzing the Executive Composite measure. This analysis had the largest effect size, likely indicating the better validity of the composite as a measure of executive control.

Discussion

We found that, considered either as continuous variables or discrete diagnostic classifications, self-

reported psychological distress symptoms were differentially associated with scores on cognitive tests. These were no-hold tasks, which are expected to show cognitive impairment, and hold tasks, which are expected to remain preserved. The pattern of hold and no-hold was as expected. Specifically, the findings of this study support the hypothesis that psychological distress is associated with poorer performance on executive functioning tasks. This was observed with two different executive function tests. In contrast, lexical decision, the putative no-hold task (expected to remain preserved), was little affected by psychological distress.

These findings align with growing evidence that executive function impairments are a transdiagnostic feature across most, if not all, psychiatric disorders[18-20]. In contrast, performance on the lexical-decision task, which we hypothesized would be a hold task, appeared to be relatively unaffected by psychological distress. This is consistent with previous studies indicating that mental health disorders, including depression and anxiety, do not significantly impact lexical decision performance[7,10,46]. Our findings also accord with a previous study that found that one of the main methods used to estimate premorbid cognitive ability in English, the National Adult Reading Test[4], was unaffected by major depression[47]. Even in cases of apparent cognitive decline associated with mild dementia, performance on lexical-decision tasks, similar to that described here, is unaffected[8,14,15].

Given that the performance of the Thai Lexical Decision Task appears to hold, our preliminary results suggest that this task may function as a premorbid estimator of cognitive function in psychiatric and neurological assessments in Thailand. Furthermore, the methodology used here could be used in other countries and language cultures to begin the process of developing valid and reliable assessment tools to estimate premorbid cognitive ability.

Although we have demonstrated that the Thai Lexical Decision Task holds in the presence of psychological distress, at least within a student sample, further research and development of the tool would be needed before it could be used in formal clinical cognitive assessments. This would include establishing normative scores. However, from a research perspective, the task could be used as is. When comparing psychiatric or neurological patients to control groups, it is usually necessary to match them on premorbid ability. This is often done through matching by years of education; however, performance measures such as the lexical task described here are usually better measures. Raw scores on the Thai Lexical Decision Task could be used to match patient and control groups, provided they are also matched on basic demographics such as age and gender, which they usually would be.

It is important to note that although we studied a non-clinical sample, it cannot be argued that the study participants simply did not have any reduction in cognitive ability. Our results demonstrate a dissociation related to psychological distress in terms of reduced cognitive performance on some tasks yet preserved on others. It is precisely this dissociation, a relative difference in the level of cognitive impairment, that can be harnessed to allow quantification of the magnitude of cognitive changes via estimation of premorbid functioning. This is also the rationale that the commercially sold premorbid assessment tools employ[4-6].

Such tools are essential aspects of clinical cognitive assessments as they set the baseline for interpreting all of the current cognitive function ability measures. Such tools can also provide valuable research insights for use in neuropsychology and behavioral neurology.

In epidemiological studies, it is generally of more interest to identify aspects of premorbid status, as these are candidate risk or protection factors. Consequently, premorbid estimates of cognitive ability form a core part of many datasets used to elucidate cognitive reserve and how this may reduce the impact of dementia despite progressive neurodegenerative changes[48]. In addition, premorbid estimation of cognitive function allows psychiatry researchers to address 'which came first' issues in populations that show combined psychiatric and cognitive disturbances. For example, substance-dependent individuals[49] and people experiencing homelessness[50].

Although the present results suggest that individuals with probable psychological distress exhibit executive function impairments, this study has certain limitations. Notably, the findings are based on data from non-clinical participants, most of whom have subclinical symptomatology, which limits generalizability. Other relevant factors are the narrow age-range and limited diversity within the sample. Opinion is divided on the use of student participants in research. Some argue that they are an appropriate population for hypothesis testing of effects likely to be common across people, e.g., cognitive functions[51], as in the current study. Nevertheless, the relatively low-levels of psychopathology in our sample would likely underestimate the associations between clinical levels of anxiety and depression symptoms and cognitive test performance. In addition, they were recruited

from a student population that may have important differences from the general adult population. These recruitment factors could potentially bias the results. Further research is underway assessing the Thai Lexical Decision Task in a clinical neurology sample.

A further limitation is the self-report scale used to quantify the severity of anxiety and depression symptoms, the HADS. Although this had values suggesting reasonable internal consistency, there is always a question over the validity of questionnaire data. We also tested several hypotheses, which would have increased the Type I error rate. Despite these limitations, the Thai version of the lexical decision task appears to perform comparably to other versions of the task in different languages, such as the English-language Spot-the-Word Test[6]. Future research should extend these findings to clinically diagnosed patients with psychiatric or neurological disorders to determine whether the observed effects persist in clinical populations.

Conclusion

This study demonstrates a dissociation between cognitive executive function impairments and preserved lexical-decision performance in individuals reporting psychological distress, reinforcing the view that executive dysfunction is a transdiagnostic marker of psychiatric symptoms. Importantly, the newly developed Thai Lexical Decision Task appears resistant to these impairments, suggesting its potential as a culturally appropriate estimator of premorbid ability for use in clinical cognitive assessments. While further validation in clinical populations is needed, and, ideally, the development of normative data, this tool may have utility for both research and clinical contexts in Thailand. It may also inform the creation and cross-cultural validation of similar tools worldwide.

Authors Contributions

GP and SCha designed the study. DR provided clinical consultation. NN collected the data. NN and RJ processed the data and performed basic analyses. GP and Scho performed the main statistical analysis. Interpretation was by GP, SCho, DR, and SCha. SCho perfomed the literature searches. DR provided additional intellectual content. Original manuscript draft was written by GP and SCho. RJ performed bibliometric formatting. All authors contributed to manuscript revision.

Clinical Trial Registration

Not applicable. This study was a cross-sectional study and was not registered as a clinical trial.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The full data supporting this research is available by request from the corresponding author.

Ethics Approval and Consent to Participate

This study was approved by the Chulalongkorn University Institutional Review Board (071/67). All participants provided informed consent prior to participation.

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Use of Artificial Intelligence

The authors declare that no artificial intelligence tools were used in the writing, analysis, or preparation of this manuscript.

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