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Review article

Effects of acceptance and commitment therapy on cognitive function: A systematic review

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ABSTRACT

Cognitive function is essential for daily activities. Acceptance and commitment therapy (ACT) may improve cognitive function by enhancing psychological flexibility, but the underlying mechanism is unknown. This systematic review evaluated the effectiveness of ACT on cognitive function. Seven research databases (PubMed, ProQuest Dissertations and Theses, Web of Science, EBSCOhost, CNKI, Scopus, Wanfang) were searched to collect articles with trials published in English and Chinese. After applying inclusion and exclusion criteria, we identified 12 studies published between 1994 and 2022 that included a combined total of 904 participants. Among the included studies were within-group (N = 3) and randomized controlled trial (RCT, N = 9) study designs. Outcome measures included cognitive scales and behavioral measurements. Of the 12 articles, 10 studies showed improvements in certain domains of cognitive function due indirectly to ACT intervention. We found that the ability of ACT intervention to promote psychological flexibility is due to its transdiagnostic nature. Also, the effects of the ACT intervention were observed in multiple cognitive domains: attention, subjective cognitive function, executive function, and memory. In conclusion, cognitive trainers could consider practicing ACT as part of their strategy to enhance an individual's psychological flexibility and cognitive function.

1. Introduction

Cognition is a type of human mental activity. It refers to the mental processes of an individual for recognizing and understanding things [1]. Cognitive functions include attention, processing speed, executive function, and memory [2], which are essential for the performance of both simple tasks and complex activities in daily life. For example, attention is at the foundation of an individual's daily life. Attention affects processing speed for hearing, visual choices, and action choices [3,4]. Both attention deficit hyperactivity disorder (ADHD) and autism sufferers have attention problems that are closely related to neuronal activity [5,6]. Executive functions are a

Abbreviations: ACT, Acceptance and Commitment Therapy; ADHD, Attention Deficit and Hyperactivity Disorder.

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series of higher-order cognitions that individuals need for setting goals, making plans, and implementing goals [7,8]. Cognitive impairment is the first change that occurs in patients with Parkinson's or Alzheimer's disease, especially impaired executive function [9,10]. Working memory is a component of executive function, and involves the ability to manipulate concentrated information in a short period of time [11]. From a cognitive developmental perspective, cognitive function is one of the most important aspects of growth for children. It is related to the ability for thinking, learning, and memory, and is also the foundation of creativity and problem-solving [12,13]. When cognitive function is impaired, adults or the elderly, they cannot act independently in daily life and are unable to live normally [14–16]. As a consequence, family members of individuals with cognitive impairments often bear intense labor, psychological and financial burdens [17–19]. Moreover, cognitive impairment issues also heavily impact the economics of medical and healthcare systems in society [20–22]. Thus, maintaining and promoting cognitive health is a considerable challenge for individuals and society.

Cognitive function is influenced by a variety of complex factors such as individual behavior [23], emotions, trauma, stress [24,25], biomedicine, and social environment [26,27], which also prompted researchers to develop innovative intervention methods for optimizing cognitive development. First, from the perspective of biomedicine, pharmacological treatment is a very common intervention [28], but this method focuses mainly on slowing cognitive decline. Second, the more commonly used method for maintaining and promoting cognitive health is non-pharmacological intervention [29]. This approach has the advantages of being economical, having few side effects, and being highly accepted [30,31]. Among them, the non-pharmacological interventions, the psychotherapeutic approach is a comprehensive non-pharmacological and biological treatment that modifies the complex underlying cognition and emotions in the brain [32,33].

Acceptance and commitment therapy (ACT) is a method of psychotherapy that was gradually developed by Steven Hayes and colleagues [34]. ACT uses mindfulness as one of its main techniques. Mindfulness meditation can affect brain function and improve cognitive function [35–37]. Studies based on neural activity have also found that mindfulness can change the neural activity that supports working memory during tactile distractions [38]. ACT is one of the representative psychotherapies of the third wave of behavioural and cognitive therapies derived from behavioral analysis [39]. The goal of ACT is to improve psychological flexibility (consciously engaging with the moment, and changing or maintaining behaviour patterns depending on their selected values), and in turn help individuals live more meaningful lives [40–42]. The therapeutic model for ACT is known as the ACT hexaflex, which includes cognitive defusion, acceptance, self as context, contact with the present moment, values, and committed action. In the ACT model, mindfulness practice is a critical component of the psychological flexibility structure. It is associated with left and central processes in hexagonal processes in psychological flexibility [40,43].

Studies have confirmed that cognitive fusion is an intermediate variable between anxiety and cognitive function [44] in people with mild cognitive impairment [45]. Cognitive fusion is an important component of the psychopathological model in ACT. When individuals are cognitively fused, individual behaviours are over-regulated and influenced by thoughts and beliefs [40,46]. These studies suggest that mindfulness and the defusion component in ACT may be an effective method for cognitive function. However, the overall effectiveness of ACT in training cognitive function is still unclear.

ACT encourages individuals to change the interaction of thoughts and feelings through the hexagonal process mechanisms [40]. ACT is a transdiagnostic psychotherapeutic intervention method. ACT does not have many requirements for the characteristics of the intervention population. It has been widely used in various fields, such as psychiatric intervention, and health promotion [47–49]. For example, Pahnke et al. conducted 12 weekly 150 min group sessions of ACT intervention in adults with autism spectrum disorder and found that participants benefited from a structured and modified ACT program. Their depression and anxiety improved, and psychological flexibility was significantly enhanced [50]. Similar results were obtained in an ACT study of psychosis and trauma by Spidel et al. After 10 group interventions, the symptoms of the participants were reduced and the ability to regulate emotions was improved [51]. ACT has also been applied to populations of different ages. ACT can reduce mental and behavioral disorders of children [52,53]. A recent meta-analysis found that ACT interventions had a significant effect on improving well-being in both clinical and non-clinical adults [54]. ACT has also been used in elderly people with dementia to improve their functional autonomy and increase the amount of activities [55]. In the study of patients with chronic diseases, the use of ACT was not affected by neuropsychological function [56].

There is a considerable body literature discussing the impact of ACT on various aspects of mental health. In the treatment of mood disorders, multiple previous studies have shown that ACT can be effective in addressing anxiety and depressive mood disorders [48,57,58]. It is also possible that ACT has a greater impact on depressive mood improvement than cognitive behavioral therapy [59]. Even chronic pain [60,61], as well as psychological and physical symptoms of family members of patients with various diseases have been improved by ACT [62]. Considering the potential of ACT, there is also an increasing number of studies investigating the effect of ACT on cognitive function, such as the effect of ACT on attention, memory, etc [63,64].

To the best of our knowledge, there are no reviews on the impact of ACT on cognitive function. Therefore, the aim of this systematic review was to provide evidence for the effectiveness of ACT on cognitive function. Cognitive outcomes were evaluated in individual and group ACT intervention experiments using cognitive scales and behavioral ratings [65,66]. It is the first systematic review of the impact of ACT on cognitive function. Our analysis has important implications for cognitive rehabilitation and enhancement of future ACT applications.

2. Methods

The protocol for this systematic review was previously registered at PROSPERO: CRD42022286104. For this review, we followed the recommendations of the PRISMA guidelines [67].

2.1. Search strategy

A comprehensive search was performed to collect all possible data for this review. The search strategy for our review considered articles, dissertations and theses that were published in English and Chinese during 1994–2022. The search period began in 1994 because the term “acceptance and commitment therapy” was first published in an article that year [39]. The following seven electronic databases were searched between January 2022 and April 2022 by two independent authors: PubMed (title, abstracts), EBSCOhost (title), ProQuest Dissertations and Theses (title, abstracts), Web of Science (title), Scopus (keywords), CNKI (title, abstracts, keywords) and Wanfang (title or keywords).

2.2. Search terms

The search terms were determined in consultation with experts in the fields of ACT, gerontology, and cognitive neuroscience and included the following English terms and the corresponding Chinese terms (see supplemental material):"Acceptance and Commitment Therapy" OR "ACT" OR "Third wave" OR "Acceptance-based" OR "Acceptance based" OR "Contextual cognitive behavi*r" AND "cognition" OR "cognitive function" OR "intelligence " OR "memory" OR ″ attention " OR "processing speed" OR "executive function" OR "neuropsychological tests" OR "cognitive dysfunction" OR "cognitive decline " OR " dementia" OR "cognitive impairment. ".

2.3. Inclusion/exclusion criteria

Published studies met the inclusion criteria if they: (a) were in English and Chinese (b) described an ACT intervention; (c) employed a method of an experimental intervention; (d) included measures of cognitive function; (e) had a sample of individuals with comprehension and thinking ability to receive and understand the intervention (unlimited population standards); and (f) Included cognitive function as a primary result or a secondary result. Studies were excluded if they: (a) did not include cognitive function outcomes; (b) included only qualitative studies; (c) were conference abstracts or reviews; (d) employed an ACT intervention that did not seek to improve psychological flexibility through at least two of the core processes (e.g., cognitive defusion or enhancing value-directed behavior); and (e) employed an intervention that included only one component of ACT (e.g., mindfulness). This exclusion criterion was set with reference to the study by Swain et al. in order to distinguish ACT from other mindfulness-based psychotherapies and to avoid duplication of review (e.g., dialectical behavior therapy, and mindfulness-based cognitive therapy) [68,69]. In addition, Ruiz et al. set that the ACT process should include at least two components of the intervention (rather than only one) according to the characteristics of the ACT hexaflex model (acceptance, cognitive defusion, being present, self as context, values, and committed action) [70].

2.4. Data extraction

The process of data collation and synthesis was carried out by all authors. Using the team function of EndNote X9(Clarivate Plc, London, UK), the full texts of the studies were screened and organized, and all relevant data from the included studies were extracted and entered into Excel (Microsoft Corp., Redmond, Washington, USA). We constructed a table (Table 1) that specifically included the following: Basic informational characteristics of the study (author, publication year, country), participant characteristics (intervention population [IG], sample size, age), methodology (intervention, study design, measures), and results.

2.5. Study quality and risk of bias

Two authors searched and screened the articles, as well as used Cochrane criteria to assess the risk of bias in each study [71]. The bias assessment consisted of the following seven items: (i) random sequence generation; (ii) allocation concealment; (iii) blinding of participants and personnel; (iv) blinding outcome assessment; (v) incomplete of outcome data; (vi) selective reporting; and (vii) other sources of bias. Each item was assessed as having a high, low, or unclear risk of bias. If the quality assessment was inconsistent, it was reassessed by two reviewers, or assessed by a third reviewer who made the final decision.

2.6. Data analysis and report

Each included study was summarized as shown in Table 1. This study followed the recommendations of the PRISMA guidelines for this systematic review. Meta-analyses were performed if the included studies were sufficiently homogenous in terms of research methods and outcomes [72]. Due to the heterogeneity of study samples, research methodologies and outcomes a meta-analysis could not be performed, so this study analysis is presented as a systematic review [73].

3. Results

1550 references were retrieved from the database (Fig. 1). After screening out duplicate references, a total of 498 articles were identified. After evaluating the title and abstracts of these articles based on our inclusion and exclusion criteria, 42 references remained. Following a final comprehensive evaluation of these 42 references, only 12 articles were eligible for inclusion in our systematic review.

Table 1
Details of the interventions data from the 12 reviewed studies.

Study	Population	Total N	IG N	IG age [CG age] (M±SD)	Country	Study design	Control conditions	Outcomes (instrument)	Findings (effect)	Sessions (duration)	Format	Treatment plan provided
1. Vanzin et al. [75]	children and adolescents with ADHD	31	31	**10.7 ± 1.4**	Italy	WG	BC	1.CPRS-R:L: Cognitive problems 2.DSM IV: Inattentive	Significant differences between scores for before *vs* after treatment. 1. $p = 0.005$, $d = 0.5$; 2. $p = 0.029$, $d = 0.45$	26 weekly sessions-90 min (9 mo)	5 children group	Yes
2. Vanzin et al. [76]	children with ADHD	47	24	**10.25 ± 1.35** [10.91 ± 1.42]	Italy	RCT	NTC	Amsterdam Neuropsychological Tasks-executive function	No significant improvements observed in any cognitive measure.	26 weekly sessions-90 min (9 mo)	Group	Yes
3. Shari et al. [77]	breast cancer patients	60	30	**46.13 ± 8.22** [48.27 ± 7.81]	Malaysia	RCT	WL	FACT-Cog	Significant differences for before *vs* after treatment. $p = 0.000$; WG: $d = 1.61$ Between Group: $d = 1.98$	4 sessions −60 min (3 mo)	Individual	Yes
4. Li et al. [78]	breast cancer patients	80	40	**37.58 ± 6.98** [38.28 ± 7.84]	China	RCT	PED	FACT-Cog	After intervention, perceived cognitive impairment scores of the IG were significantly lower than those of the CG. $P = 0.000$	8 sessions-6 x 90 min and 2 × 120 min (2 mo)	Individual and 4–6 people group	Yes
5. Yang et al. [79]	patients with cerebral infarction	112	56	**55.2 ± 5.84** [55.14 ± 5.72]	China	RCT	PED	MoCA	After intervention, cognitive function score (MoCA) of the IG was significantly higher than that of the CG. $P < 0.05$	8session-40min (1 mo)	Individual	Yes
6. Shameli et al. [64]	patients with multiple sclerosis	30	15	**35.30 ± 8.18** [34.6 ± 7.80]	Iran	RCT	NTC	Stroop Test and Wechsler Memory Scale-III	Improved executive function and working memory	6 Sessions 120 min (6 wk)	Individual	Yes
7. Herbert et al. [56]	veterans with chronic pain	117	117	**52.11 ± 13.59**	USA	WG	BC	Color-Word Interference test; Letter-Number Sequencing test; Long-Delay Free Recall test; CVLT-II	Executive functions, working memory, processing speed, learning and verbal memory; All study measures significantly improved from baseline to post-treatment	8sessions-90 min (2 mo) Follow-up	Individual	Yes-refer to Wetherell et al. [80]
8. Enoch et al. [63]	children	21	10	**8.25** [8.25]	USA	RCT	NTC	CPT Task; Go/No-Go Task; Visual Cancellation Tasks	CPT-X task compared to the CG ($M = 19.75$, $SD = 16.1$) at post test $F(1, 38) = 11.49$, $p = 0.02$, $\eta p^2 = 0.232$. ACT intervention positively impacted sustained attention.	6 sessions-20min (1mo)	4 children group	Yes

(*continued on next page*)

Table 1 (*continued*)

Study	Population	Total N	IG N	IG age [CG age] (M±SD)	Country	Study design	Control conditions	Outcomes (instrument)	Findings (effect)	Sessions (duration)	Format	Treatment plan provided
9. Svanberg et al. [81]	individuals with substance-use disorder	18	18	**21–65**	Sweden	WG	BC	BRIEF-A	Positive changes for psychological flexibility and for 9 of 10 executive functions (e.g., inhibitory control, task monitoring, and emotional control). ACT can improve executive function	7 sessions −90 min (3 wk)	Individual	No
10. Yaselyani [82]	individuals undergoing maintenance treatment after drug abuse	30	15	**unclear**	Iran	RCT	NTC	Stroop test; Wisconsin Card Classification test; ($p > 0.05$)	The treatment based on acceptance and commitment to executive function after cessation of drug use has not been effective in maintenance therapies.	6sessions-90 min (6 wk)	Group	Yes
11. Bannon [74]	undergraduate students	88	32	**18.75 ± 1.05** [20.75 ± 4.52]-CT (cognitive therapy) [20.13 ± 2.82]-HL (health living)	USA	RCT	TAU; PED	Phonological Loop Task; Central Executive Task (Stroop); Visuospatial Task (N-back)	ACT condition had significantly higher digit span forward performance, Stroop performance than CT condition ($p = 0.003$). No significant difference between conditions for N-back (working memory).	1 session −120 min (2 h)	6-12 student group	Yes
12. Takahashi et al. [83]	Adolescents	270	67	**14.06 ± 0.30** [14.09 ± 0.30]	Japan	RCT	WL	Strengths and Difficulties Questionnaire	ACT reduced hyperactivity/ inattention.	6 sessions-50 min (6 wk)	Group	Yes

Note: ADHD = Attention Deficit Hyperactivity Disorder, CG=Control Group, DSM = Diagnostic and Statistical Manual of Mental Disorders, IG=Intervention Group, M = Mean, SD = standard deviation. Study design : Randomized Controlled Trial (RCT), Within-Group (WG).
Control conditions: Baseline Control (BC), No-Treatment Control (NTC), Psychoeducation (PED), Treatment-As-Usual (TAU), Wait List (WL).
Outcomes (instrument): BRIEF-A = Behavior Rating Inventory of Executive Function – Adult Version, CPRS-R:L = Conners' Parent Rating Scales-Revised: Long Version [84], CPT=Continuous Performance Test, CVLT-II=California Verbal Learning Test-II, FACT-cog = Functional Assessment of Cancer Therapy-Cognitive [85], MoCA=Montreal Cognitive Assessment.

3.1. Overview of included studies

Table 1 provides an overview of the 12 included studies. All studies were published journal articles (N = 11) or doctoral dissertations (N = 1, [74]]). Each study was reviewed and key information pertaining to study design was extracted (e.g., participants, age, design, and cognitive outcomes). Based on the study inclusion and exclusion criteria mentioned, there were 12 published articles related to the impact of ACT on cognitive function. The combined total population of these studies comprised 904 participants, and included children, adolescents, undergraduate students, patients (breast cancer, cerebral infarction or chronic pain), and individuals who had a sub-stance-use disorder, or were undergoing maintenance treatment after drug abuse.

3.2. Sample characteristics

There was a combined total of 904 participants in the 12 reviewed studies. The smallest and largest studies had 18 and 270 participants per study, respectively. Among the 904 participants, there were 455 participants in the intervention groups (IGs) and 449 participants in the control groups (CGs). In general, most of the studies were of adults (age range: 8 to 60 years).

3.3. Study design and treatment conditions

Regarding study design, there were three within-group (WG) studies and nine randomized controlled trials (RCTs). The three WG studies compared only the pre-test and post-test intervention data of one group of participants who received the ACT intervention [56,75,81]. In contrast, the 9 RCTs adopted a between group design, which compared data from the ACT intervention and another intervention method (general psychological education [PED] [74,78,79], cognitive therapy [74]) of at least two groups (intervention

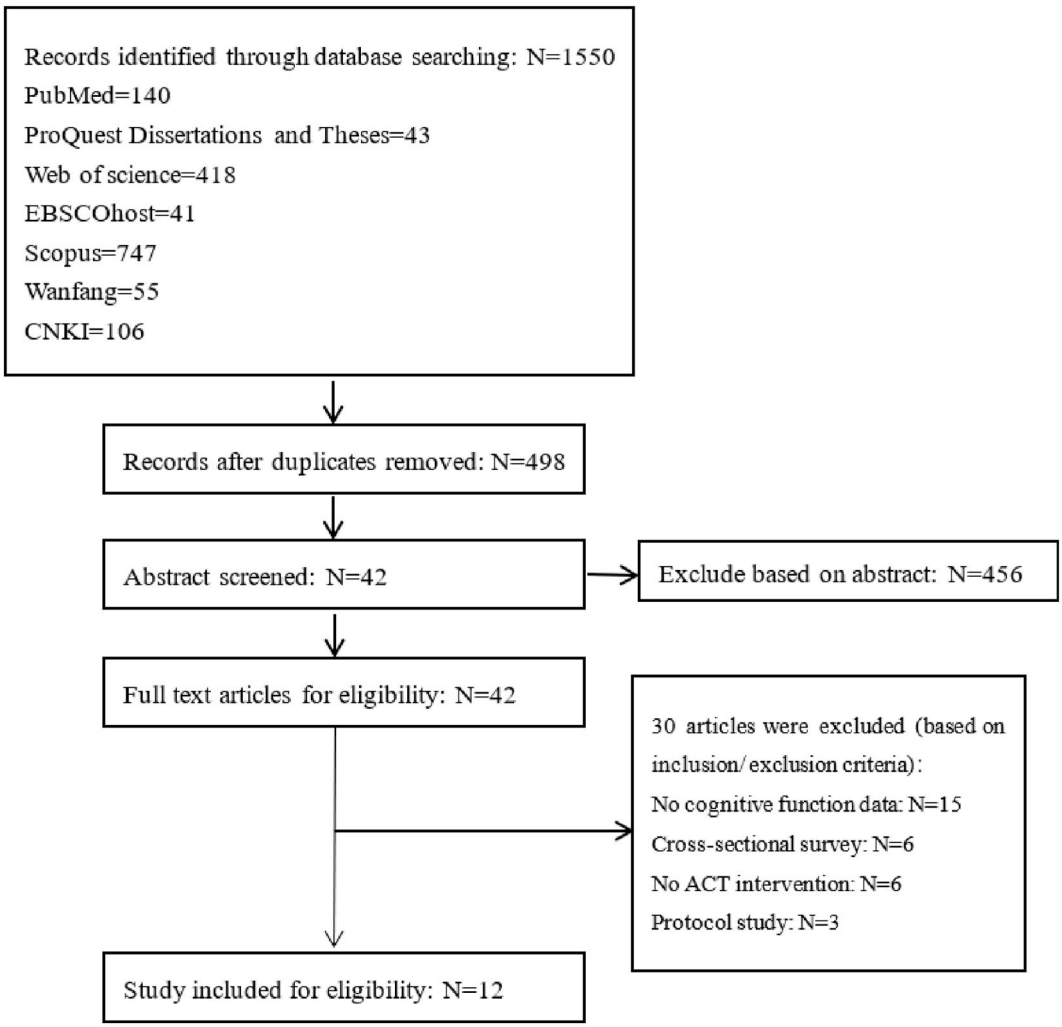

Fig. 1. Flow diagram of the selection process of articles for the systematic review.

group, wait list [WL] group [77,83], CG [63,64,76,82]).

The characteristics of the ACT interventions are shown in Table 1. The duration of interventions ranged from 120 min to 9 mo. The number of interventions ranged from 1 session to 26 sessions, with the duration of each session varied from 20 min to 120 min. Half of the studies used 90-min sessions. The form of treatment also differed, as follows. five studies used individual intervention, six studies used group intervention, and one study used both individual and group intervention. One of the individual intervention studies did not provide intervention plans [81].

3.4. Measured outcomes

Our review combined the research of cognitive function, and comprehensively evaluated the effect of ACT on cognitive function. Cognitive function was primarily measured by scales and behavioral ratings that comprised complete cognitive measurement (Montreal Cognitive Assessment (MoCA)), attention test (Conners' Parent Rating Scales-Revised: Long Version [CPRS-R: L], cognitive problems/inattention, Diagnostic and Statistical Manual of Mental Disorders [DSM] IV, Strengths, and Difficulties Questionnaire, Visual Cancellation tasks), subjective cognitive measurement (Functional Assessment of (Cancer Therapy-Cognitive [FACT-Cog]), executive function (Stroop test, Colour-word Interference test, Continuous Performance Test [CPT] task, Go/No-Go task, Inventory of Executive Function, Wisconsin Card Classification, N-back, Amsterdam Neuropsychological tasks), memory (Letter-Number Sequencing test, Wechsler Memory Scale-III, California Verbal Learning Test-II [CVLT-II], and verbal memory (Long-Delay Free Recall test).

There were two studies of ACT intervention ADHD. One study showed that after nine months of small-group intervention in children and adolescents with ADHD, cognitive problems were significantly reduced, and inattention was also improved [75]. However, the same intervention for children with ADHD did not show significant changes in executive function [76]. Another ACT intervention study of adolescents demonstrated that ACT can reduce inattentiveness problems [83]. In two studies of breast cancer patients, the cognitive impairment results of FACT-Cog were significantly reduced [77,78]. There was also a study of patients with cerebral infarction. After 1 month of individual treatment with ACT, the MoCA score of the IG increased significantly [79]. Regarding executive function, there were five studies with consistent results showing that ACT intervention helped to improve executive function [56,63,64,74,81], especially inhibitory function. ACT had no effect on executive function in a study of individuals undergoing maintenance treatment after drug abuse [82].

3.5. Study quality assessment

The risk of bias was assessed by two independent authors. Based on Cochrane criteria (Table 2) [86]. Four studies were classified as high-risk selection bias based on the criterion of "random sequence generation" because three studies did not have CGs [56,75,81] and it was unclear in the fourth study [82]. There was also a study in which the IG and CG were determined based on the time of admission to the hospital [78]. In Enoch & Dixon's study, the risk of selection bias was unclear as they did not specify whether a randomization method was chosen [63]. In terms of performance and detection bias, based on the criterion of "blinding of participants and personnel"

Table 2
Risk of bias summary for the 12 reviewed studies based on Cochran criteria.

Article	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias
1.Vanzin et al. [75]	–	–	–	+	+	+	?
2.Vanzin et al. [76]	+	+	–	+	+	+	?
3.Shari et al. [77]	+	+	?	+	+	+	+
4.Li et al. [78]	–	?	+	+	+	+	?
5.Yang et al. [79]	+	+	+	+	+	+	+
6.Shameli et al. [64]	+	+	?	+	+	+	?
7. Herbert et al. [56]	–	+	?	+	+	+	?
8.Enoch et al. [63]	?	?	–	+	+	+	?
9.Svanberg et al. [81]	–	–	+	+	+	+	?
10.Yaselyani [82]	–	–	+	+	+	+	?
11.Bannon [74]	+	+	–	+	+	+	+
12.Takahashi et al. [83]	+	+	+	+	+	+	?

Note: : high risk, +: low risk, ?: unclear.

four studies were rated as high risk [63,74–76], five studies were low risk [78,79,81–83], and the other three studies had unclear risk [56,64,77]. All studies used appropriate statistical analysis methods for data processing. All studies were rated as low risk or reporting bias, since results from the measures used, as well as non-significant results were reported.

4. Discussion

This is the first systematic review to evaluate the impact of ACT on cognitive function. This review included only experimental research, which increases the strength of our evaluation. This systematic review synthesized the results of 12 studies and ten of these studies showed a positive effect of ACT intervention on cognitive function. Only two studies reported an insignificant effect. On the one hand, the study samples are heterogenous so it is difficult to draw general conclusions. However, on the other hand, the diversity of samples indicates the wide applicability of ACT [87–89]. ACT can play a positive role in intervening in the cognitive function of children and adults. In addition, in the included studies, the sample size ranged from 18 to 270, and the sample size in most studies was small. Previous studies have demonstrated that sample size affects results. Therefore, it is better to use a larger sample size when practical conditions permit [90,91].

This study identified 12 eligible studies involving treatment of a variety problems. Although the literature is still in its infancy, the evidence available to date indicates that ACT has produced significant improvements in the clinical results reported by most self-report and neuropsychological tests. These findings support the arguments of several researchers (such as Petkus [92]), who believe that ACT is a viable treatment for problems with cognitive function [92]. These results support the assertion that ACT has the potential to be useful as a cross-diagnostic method [34]. This is an area where future research is warranted in larger, methodologically rigorous trials with multiple clinical manifestations.

In this review study, we found differences in outcome measures. Among them, most of the measurement methods were questionnaires and behavioral ratings. According to previous research, cognitive function is divided into many domains [93], such as memory, attention, and executive function. Different cognitive domains require the use of different outcome measures. Therefore, we were unable to determine the effect of ACT on specific domains of cognitive function. To more fully explore the effect of ACT on cognitive function, future research could focus on a specific cognitive domain or measure multiple domains. The results of such studies would make it easier to draw conclusions about which cognitive domains benefit the most from ACT. In addition, the incorporation of brain imaging into future studies to explore the mechanisms underlying the effects of ACT on cognitive function could be considered.

According to current research, it is clear that more high-quality research is needed to further determine the effectiveness of ACT. Despite the limitations, previous studies have shown the positive effects of ACT interventions on pain, depression, sleep, and anxiety [48,94]. These findings show that ACT can be considered by clinicians. In some other studies, results measured after the ACT intervention (post-test) found that while intervention did not immediately have a significant effect on the participants, greater improvements in the participants' depressive symptoms and quality of life occurred in a few months post-intervention [95,96]. Therefore, the addition of follow-up time points to future studies is an important consideration.

Our review found that the duration and frequency of ACT intervention programs were different. This involves the "dose" of ACT. Although the application of ACT does not have too many restrictions on the population [97], the intervention program should be adaptive [98]. Individualized intervention plans should be formulated according to the development of ACT treatment theory. For example, the frequency and duration of interventions for children and the elderly should be adjusted [92]. There are also cultural aspects of the interventions that should be taken into account, such as the use of metaphors [99].

In the overall methodological quality assessment in this review, more than half of the treatment options were detailed enough to allow replication. Future research should continue to adhere to these practices. However, some cautions have been identified and should be addressed in ongoing research. One study did not report therapist training, treatment compliance, or therapist competence [75]. In other studies, the effect size could not be calculated [78,79]. In some studies, there was a lack of control or alternative treatment comparisons in the study design, which limits the conclusions. However, due to the use of naturalism, these studies may provide clinicians working in real-world settings with greater effectiveness than randomized efficacy trials. In ACT research, is there a different effect of individual intervention and group intervention different? It is not yet possible to answer this question based on existing research [100,101]. Therefore, comparative studies of intervention forms are necessary for the future.

The results of this study show that ACT intervention can improve cognitive function. Synthesizing data from this review found that two factors may have an impact on cognitive function. Firstly, ACT can help people develop the ability to focus. Individuals can develop attention to their own behaviour through techniques of mindfulness and observational self so that they can focus on what is important. It can help individuals conserve cognitive resources through acceptance, and help individuals keep distance from worries or distractions unrelated to the current task through cognitive dissociation. Importantly, ACT intervention can also improve an individual's psychological flexibility, which can help individuals focus their energy on things that are beneficial to them. In Svanberg's research [81], it was demonstrated that there is a significant correlation between psychological flexibility and executive function. Secondly, ACT can help individuals accept and improve negative emotions through mindfulness, cognitive defusion, and metaphor, thereby improving cognitive function. That is to say, ACT has a substantial impact on cognitive function, and studies have also proved that point [102,103]. In addition, previous studies have demonstrated that cognitive fusion can affect cognitive function [44]. It is possible that cognitive trainers could collaborate with ACT therapists to improve the cognitive function of clients or patients in clinical practice.

5. Strengths and limitations

In conclusion, the research studies included in this systematic review showed that ACT has a positive effect on cognitive function. A new scope for applying ACT interventions is apparent. The comprehensive nature of our review provides evidence for the potential use of ACT-based interventions for cognitive function in various populations and diseases. It is also strong evidence for others who are looking for interventions that affect cognitive function.

Some limitations of our review should be considered. Firstly, although different databases and keywords were included in this study, articles written in languages other than English and Chinese may have been excluded. The future researches could be extended to databases containing publications in other languages.

Secondly, owing to the heterogeneity of sample and study methods, it was not possible to carry out a statistical meta-analysis. At the same time, the exact therapeutic components of ACT cannot be determined. In order to consolidate and build on this preliminary evidence, it is necessary to conduct a larger scale of methodologically rigorous experiments within a wider range of presentation problems. Future research can start with specific intervention prescriptions, such as intervention frequency, form (individual or group, face to face or online), comparison with other methods, and follow-up studies.

Thirdly, with regard to limitations of quality assessment, in order to reduce publication bias, all types of experimental studies were included in this review. However, non-RCT studies need to consider a greater risk of bias when interpreting the validity of the results. Considering that this may affect the replication of the results of this systematic review, it remains a limitation, although the subjective interpretation of risk of bias is a problem for any quality assessment method. Therefore, future research could use the POMRF questionnaire [104] to address this limitation.

Our systematic review contributes to the literature concerning the implementation of ACT for cognitive function. Ultimately, it is hoped that the results of this study will support the development of future research in the field of ACT and cognition.

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

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Data availability statement

No data was used for the research described in the article.

Declaration of interest's statement

The authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e14057.

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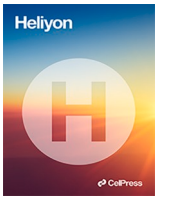

Corrigendum

Corrigendum to "Effects of acceptance and commitment therapy on cognitive function: A systematic review" [Heliyon 9(3) (March 2023) e14057]

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