Mechanisms of Action in Acceptance and Commitment Therapy: A Meta-Analytic Structural Equation Modeling Approach

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Abstract

Acceptance and Commitment Therapy (ACT) is considered a prominent representative of the "third wave" of behavioral therapy. This study employed meta-analytic structural equation modeling to investigate the mechanism of action of ACT. Through database searching and screening, a total of 50 studies were included. The results revealed that: the mediating effects of psychological flexibility, acceptance, present moment, and values as hypothesized by ACT all achieved statistical significance, whereas the mediating variable of cognitive defusion was not significant; the mediating mechanism was still verified in web-based interventions; compared to traditional CBT, ACT demonstrated advantages in its hypothesized mechanisms that distinguish it from CBT. Future clinical research should more comprehensively measure the six core mechanisms, focus on the impact on enhancing well-being, adopt ecological momentary assessment methods, and utilize more advanced and sophisticated statistical methods to examine its mechanism of action whenever possible.

Full Text

Mechanisms of Acceptance and Commitment Therapy: A Meta-Analytic Structural Equation Model

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Abstract

Acceptance and Commitment Therapy (ACT) is recognized as a principal representative of the "third wave" of behavior therapy. This study employed meta-analytic structural equation modeling (MASEM) to investigate the mechanisms of ACT. Following systematic database searching and screening, 50 studies were ultimately included. Results revealed that the hypothesized mediating roles of psychological flexibility, acceptance, present moment awareness, and values all reached statistical significance, whereas cognitive defusion did not emerge as a significant mediator. These mediating mechanisms remained robust in internet-delivered interventions. Compared to traditional Cognitive-Behavioral Therapy (CBT), ACT demonstrated distinct advantages in its hypothesized mechanisms. Future clinical research should more comprehensively measure all six core mechanisms, examine impacts on enhancement of quality of life, adopt multiple time-point assessments, and employ more advanced statistical methods to test its mechanisms of action.

Keywords: acceptance and commitment therapy; meta-analytic structural equation model; mechanism of action; mediation analysis; cognitive-behavioral therapy

In recent years, the emerging "third wave" of behavior therapy has garnered considerable attention. Behavior therapy, termed the "first wave," focused directly on problematic behaviors and emotions based on principles of conditioning and new learning. The "second wave" emphasized correcting irrational thoughts, pathological cognitive schemas, or faulty information processing to alleviate or eliminate symptoms, giving rise to what is known as Cognitive-Behavioral Therapy (CBT) [**?**]. The "third wave," however, demonstrates greater sensitivity to the context and function of psychological phenomena rather than merely their form [**?**], with representative approaches including Acceptance and Commitment Therapy (ACT), Dialectical Behavior Therapy (DBT), Mindfulness-Based Cognitive Therapy (MBCT), and Compassion-Focused Therapy (CFT) [**?**].

Although researchers continue to debate which therapies belong to the "third wave," consensus outweighs disagreement. Hayes, Villatte, Levin, and Hildebrandt [**?**] revised the conceptualization, proposing the umbrella term "Contextual Cognitive Behavioral Therapy"(CCBT) to emphasize the "open, active, and aware"characteristics of these emerging therapies in their theoretical frameworks, therapeutic processes, and procedures, rather than focusing on which specific treatments should be included. Among these contextual CBT approaches, ACT

has received the most attention and has been cited most frequently in recent years [**?**]. The present study aims to systematically examine the mechanisms of ACT, its specificity compared to traditional CBT, and the generalizability of these mechanisms to internet-based interventions.

1.1 Efficacy of ACT

Before exploring the mechanisms of ACT, its effectiveness must first be established. In evidence-based psychotherapy, Randomized Controlled Trials (RCTs) are considered the "gold standard" for treatment evaluation, with meta-analytic evidence representing the highest standard of validity [**?**]. Treatment efficacy is typically distinguished as either absolute or relative. Absolute efficacy examines whether a treatment is effective, generally using waitlist (WL), treatment-as-usual (TAU), or placebo controls. Relative efficacy assesses whether a treatment is more effective than other established therapies, typically using highly structured, well-established treatments such as traditional CBT, Cognitive Therapy (CT), or humanistic therapy as comparison groups [**?**]. How effective is ACT?

From an absolute efficacy perspective, meta-analytic results support moderate to large effect sizes for ACT. The earliest meta-analysis, which included 9 RCTs with WL, TAU, and psychological placebo controls, found a moderate post-treatment effect size (d = 0.66) for ACT [**?**]. A more recent meta-analysis incorporating 60 RCTs covering a broader range of psychological, physical, and work stress-related problems found moderate to large post-treatment effect sizes compared to WL (g = 0.63), TAU (g = 0.55), and psychological placebo (g = 0.59) [**?**].

From a relative efficacy perspective, effect sizes vary when compared to highly structured, established therapies. The earliest meta-analysis found a moderate to large effect size (d = 0.73) for ACT compared to traditional CBT and CT, but this was based on only 4 RCTs [**?**]. Subsequently, Ruiz [**?**] conducted a meta-analysis of 16 RCTs addressing addiction, chronic pain, anxiety, depression, stress, and psychological experiences of cancer, finding small to medium post-treatment and follow-up effect sizes (g = 0.37; g = 0.42) compared to traditional CBT. A larger RCT study [**?**] found a small post-treatment effect size (k = 60, g = 0.16). A recent meta-analysis of 39 RCTs, limited to clinically relevant disorders with interventions comprising at least 80% ACT, reported similar results [**?**].

In summary, meta-analyses examining ACT' s absolute efficacy demonstrate that ACT is effective, making its mechanisms of action worthy of further investigation.

1.2 Research Methods for Psychotherapy Mechanisms

Mechanisms explain the processes of change, and identifying mediating variables is a crucial step in testing mechanisms of action. Mediating variables statisti-

cally explain the relationship between independent and dependent variables, clarifying why and how treatments affect outcomes [**?**]. Kazdin [**?**] outlined basic criteria for identifying psychotherapy mechanisms or mediators. First, the proposed mechanism/mediator must be strongly associated with the expected outcome variable (strong association criterion). Second, outcome and mediator variables must be measured at multiple time points to establish that changes in the mediator precede changes in the outcome (temporal precedence criterion). Third, experimental designs should manipulate (increase or decrease) specific mechanisms to establish specificity of effects (specificity criterion). Additionally, "dose-response" relationships should be observed, where greater activation of a mechanism produces stronger outcomes (gradient criterion). Finally, findings should be replicable (consistency criterion).

Statistically, establishing a mediating variable requires numerous conditions. For a long time, mediation referred only to statistical mediation—demonstrating that a treatment' s effect on an outcome could be explained through a third variable (mediator M). Various mediation analysis methods exist, with manifest variable tests typically based on linear regression models and latent variable tests using Structural Equation Modeling (SEM). Although SEM offers advantages over linear regression and is recommended by researchers, traditional linear regression remains the most popular approach in psychotherapy mediation research [**?**]. The classic method for testing mediation is the causal steps approach [**?**], which requires: (1) a significant treatment main effect (efficacy test); (2) association between treatment and mediator change (intervention test); (3) association between mediator change and outcome change (psychopathology test); and (4) when the mediator is statistically controlled, the treatment effect becomes non-significant (complete mediation) or significantly reduced (partial mediation) [**?**].

While statistical mediation testing is important, identifying treatment mediators requires additional experimental designs. According to more recent criteria, mediator identification should be theoretically grounded, employ rigorous RCTs with repeated measurements at appropriate intervals, and have adequate statistical power and suitable control groups [**?**, **?**]. Furthermore, experimental designs should manipulate the proposed mediator within treatment studies [**?**]. Moreover, evaluating a single mediator is often insufficient; researchers recommend including multiple competing mediators, testing alternative explanatory models, and examining interactions among theoretically proposed mediators [**?**].

1.3 Mechanisms of ACT

ACT is based on Relational Frame Theory, and its psychopathological model hypothesizes six core components: acceptance (willingness to contact internal experiences), cognitive defusion (experiencing cognition as an ongoing process rather than allowing it to over-regulate behavior), self-as-context (taking internal experiences as the context of self-experience rather than the experience itself), contact with the present moment (flexibly contacting internal and exter-

nal events as they occur without judgment), values (choosing desired outcomes that establish reinforcers for ongoing behavioral patterns), committed action (flexibly taking action toward valued directions), and enhanced psychological flexibility [**?**, **?**, **?**]. Does empirical research support these hypothesized mechanisms?

First, current empirical tests of ACT' s psychopathological model yield inconsistent results. Some studies have verified that changes in psychological flexibility mediate clinical outcomes [**?**], while others have found inconsistent results, such as failure to detect partial or complete mediation of acceptance of pain between experimental conditions and follow-up clinical outcomes [**?**]. Other research found inconsistent effects of changes in psychological flexibility and the six core mechanisms on anxiety disorders in community settings [**?**, **?**]. One meta-analysis [**?**] examining 63 studies on the relationship between anxiety and psychological flexibility found moderate correlations in both clinical and non-clinical samples, providing moderate support for psychological flexibility as a potential mediator of therapeutic change. However, this meta-analysis only examined correlations between psychological flexibility and symptom reduction, not direct mediation effects. Can aggregating relevant studies to test mediation support ACT' s psychopathological mechanism model?

Second, are ACT' s hypothesized mechanisms specific? ACT emphasizes the uniqueness of its mechanisms. Hayes [**?**] argued that although the "third wave" shares intervention components with "second wave" CBT (e.g., self-monitoring, exposure, response prevention), they differ in theoretical assumptions and intervention methods. Theoretically, unlike traditional CBT, ACT is based on Relational Frame Theory and functional contextualism. In terms of intervention methods, traditional CBT focuses on the content and validity of cognitive processes, whereas ACT emphasizes functional awareness of cognition and emotion [**?**]. Therefore, ACT emphasizes enhancing acceptance, mindfulness, metacognition, and psychological flexibility while reducing experiential avoidance to establish broader, more flexible, and effective coping strategies, rather than merely disputing cognitive content related to symptoms [**?**, **?**]. Do comprehensive analyses demonstrate that ACT' s emphasized mechanisms are indeed distinct from traditional CBT?

Third, can these mechanisms be generalized to internet-based interventions? Among all factors influencing psychotherapy outcomes, the therapeutic alliance is considered the most significant contributor, with treatment techniques accounting for relatively small effect size improvements [**?**]. With advances in computer network technology, internet-delivered interventions for mental disorders have attracted considerable research attention. Internet interventions virtually eliminate the therapeutic alliance, yet some classic interventions (e.g., internet-based CBT) have demonstrated that their mechanisms can still be tested [**?**]. However, current findings on mechanisms in internet-delivered ACT interventions are inconsistent. For example, one study of 234 college students receiving a mental health intervention found that enhanced psychological flexibility in

the ACT condition was strongly associated with improved mental health [?], and an internet-based ACT intervention for depression also supported the association between changes in psychological flexibility and symptom change [?]. Conversely, other studies found that although internet-based ACT interventions significantly improved depression and anxiety symptoms compared to waitlist controls, participants' psychological flexibility did not change significantly [?]. Therefore, systematic examination of whether ACT' s emphasized mechanisms can be generalized to internet-based environments is necessary.

1.4 Purpose of the Present Study

In recent years, the integration of meta-analysis and structural equation modeling has produced Meta-Analytic Structural Equation Modeling (MASEM) [?], enabling systematic examination of psychotherapy mechanisms. Compared to individual RCT studies, two-stage MASEM aggregates multiple samples to increase statistical power and obtain more stable model estimates [?]. Given the lack of systematic examination of ACT' s mechanisms, uncertainty regarding their specificity compared to traditional CBT, and questions about generalizability to internet-based interventions, the present study used MASEM to investigate three aspects of ACT' s mechanisms: (1) testing the mediating effects of psychological flexibility and the six core components in ACT treatment; (2) examining whether ACT' s emphasized mechanisms demonstrate specificity compared to traditional CBT; and (3) assessing the generalizability of ACT' s mechanisms, particularly in internet-delivered interventions.

2.1 Literature Search

English-language literature was searched in Web of Science, PsycARTICLES, PsycINFO, PubMed, Elsevier, EBSCO, and Wiley Online Library. Search terms combined "Acceptance and Commitment Therapy" with acceptance, cognitive defusion, self-as-context, committed action, contact with the present moment, values, or psychological flexibility. The initial search was conducted in October 2016, with a second update in November 2017. Study selection was performed by the second author and verified by the third author, with disagreements resolved through consultation with the first author. The detailed process is illustrated in Figure 1 [Figure 1: see original paper].

2.2 Inclusion and Exclusion Criteria

Inclusion criteria were: (1) adult samples (age $>$ 18); (2) randomized controlled trials (RCTs) or quasi-experimental designs measuring pre-post changes with ACT interventions; (3) quantitative assessment of psychological outcome changes (clinical or non-clinical) before and after treatment; and (4) quantitative assessment of mediating variables before and after treatment. Exclusion criteria were: (1) mixed interventions combining ACT with other treatment components, interventions containing only acceptance components without com-

plete ACT, or CBT with acceptance components [**?**, **?**, **?**]; and (2) medication treatment control groups [**?**].

Data extraction was conducted in two categories. Descriptive study characteristics were extracted by the second author and verified by the third author. Core data for statistical analysis were independently coded by both the second and third authors, yielding an inter-rater reliability kappa coefficient of 0.89. Based on the criterion that values 0.75 indicate excellent agreement [**?**], this demonstrates high coding consistency. Final coding was determined after consultation with the first author.

2.3 Mediation Testing: Two-Stage Structural Equation Meta-Analysis

Mediation effects were tested using MASEM. Cheung [**?**] proposed Two-Stage Structural Equation Modeling (TSSEM) with maximum likelihood estimation for more precise standard error estimation. The metaSEM package (Ver.1.2.0) in R (Ver.3.5.2) was used for TSSEM analysis [**?**].

2.3.1 Examining Measurement Invariance of Model Factors (Stage 1 Analysis)

To reduce potential artificial factors in aggregated data from original studies that could affect structural equation parameter estimation, this study addressed five potential sources of artifact based on recommendations [**?**, **?**]:

(1) **Data independence**. Non-independence of data violates meta-analytic assumptions [**?**]. To ensure data independence for two-stage random-effects MASEM analysis, when a study measured multiple outcomes, we adopted systematic selection methods from previous research [**?**]: priority was given to global psychopathology measures, followed by depression and anxiety measures. For studies with both clinician-rated and self-rated outcomes, clinician ratings were prioritized [**?**]. For studies measuring both anxiety and depression, the outcome matching the sample size was selected; if sample sizes differed, the outcome with higher baseline levels of depression or anxiety was chosen. For studies measuring neither depression nor anxiety, stress was selected as the mental health outcome; if stress was unavailable, negative affect was chosen. Finally, if a single outcome variable had multiple measurement instruments, the measure with stronger psychometric properties was selected. Conversely, studies without mental health outcomes were excluded from TSSEM analysis. Although computing mean effect sizes across multiple outcomes within a study is possible, the variance of average correlation coefficients cannot be directly obtained; therefore, extracting a single mental health outcome indicator per study is more appropriate.

(2) **Coding process**. The primary aim of this study was not to examine

ACT' s effect sizes for treating mental disorders but to investigate its mechanisms of action. Therefore, to examine ACT' s mechanisms using TSSEM, pairwise correlations were extracted from each article among: X (ACT vs. control group), M variables (changes in mediators from pre- to post-intervention), and Y variables (changes in outcome variables from pre- to post-intervention), along with sample sizes for each study. If studies did not provide explicit correlation coefficients, they were computed from means, standard deviations, t-values, F-values, and effect sizes (d or g values) [**?**, **?**].

(3) **Assessing potential missing data impact**. Meta-analyses may suffer from the "file drawer problem," where non-significant findings are less likely to be published than significant ones, leading to publication bias [**?**]. We first assessed potential publication bias using Begg and Mazumdar rank correlation and Egger' s regression intercept. If bias was detected, we used fail-safe number (Nfs) to examine its impact on effect sizes [**?**]. Nfs represents the minimum number of studies required to nullify current conclusions; larger Nfs values indicate lower likelihood of bias. Publication bias should be considered when Nfs is less than 5k+10 (where k is the number of original studies) [**?**]. In this study, most Nfs values were large (except possibly for the c-path in ACT vs. CBT comparisons), indicating robust overall results.

(4) **Examining Type II error**. Statistical power is a crucial component of statistical testing—the probability of rejecting a false null hypothesis. To evaluate Type II error risk, we used G*Power 3.1 to calculate statistical power based on combined sample sizes and pooled correlation coefficients for hypothesized mediators [**?**]. Power analysis results (Table 1) showed that all parameters exceeded the widely accepted threshold of 0.8, except for the A→C path for cognitive defusion, which was 0.771. Therefore, we can be confident that all MASEM models had adequate statistical power to reject false null hypotheses [**?**, **?**].

(5) **Heterogeneity in MASEM**. Both fixed-effects and random-effects models can be used in MASEM [**?**]. Following Cheung and Chan' s [**?**] recommendation, given variability in samples, study designs, and effect sizes across studies, random-effects models are preferred for MASEM. If results demonstrate homogeneity of effect sizes, fixed-effects models may be used in the second-stage analysis. Heterogeneity was examined using Q statistics and I^2 values: $Q < 0.05$ indicates heterogeneity among studies; $I^2 > 50\%$ indicates high heterogeneity, 25%-50% moderate heterogeneity, and $< 25\%$ low heterogeneity [**?**]. Results are presented in Table 1.

2.3.2 Evaluating SEM Models (Stage 2 Analysis)

Following Cheung' s [**?**] procedure for two-stage random-effects MASEM, the second-stage analysis uses meta-analysis to pool effect sizes from original studies

and combines SEM techniques for parameter estimation. Specifically, because not all variables were measured simultaneously in all original studies, we used weighted matrices and asymptotic covariance matrices to correct for heterogeneity in pooled correlation coefficients and differences in sample sizes across correlation matrices [**?**]. Non-standardized regression coefficients and standard errors from the pooled matrix were used for Sobel tests to examine the significance of indirect paths in mediation models [**?**].

3.1 Description of Included Studies

This study ultimately included 50 studies in the meta-analysis, comprising 44 RCTs addressing various psychological problems including pain disorders, personality disorders, depression, anxiety, substance abuse, and even work-related burnout in non-clinical populations (see Appendix Table 1 for details). Most studies examined psychological flexibility (k = 39), followed by present moment awareness (k = 14), acceptance (k = 6), cognitive defusion (k = 9), and values (k = 5). Self-as-context [**?**] and committed action [**?**] were each represented by only one study and thus excluded from further MASEM analysis. Although 14 studies measured multiple ACT-hypothesized mechanisms (>1), none simultaneously measured all six core mechanisms.

Most studies measured ACT-hypothesized mechanisms but did not statistically test mediation effects (k = 33). Only a minority (k = 16) used the recommended bootstrap method for mediation testing [**?**], while some studies still used traditional regression-based causal steps approaches [**?**]. Some studies employed more complex mediation methods such as multilevel (HLM) mediation models [**?**, **?**] and structural equation modeling [**?**]. While HLM has advantages for small-sample analyses, it assumes normal distributions, whereas bootstrap methods are more robust to non-normality [**?**].

Regarding experimental design, few studies considered the temporal sequencing of mechanism variables. Only 8 studies used multiple measurement points, mostly pre-treatment, post-treatment, and follow-up assessments [**?**, **?**, **?**, **?**], where follow-up occurred after treatment completion rather than during the active treatment phase. A few studies measured mechanism variables during treatment [**?**, **?**], and some conducted multiple measurements across treatment sessions [**?**], but very few measured both mechanisms and outcomes after each treatment session [**?**].

3.2.1 Psychological Flexibility

As an overarching construct for the six ACT mechanisms, psychological flexibility was examined in 39 studies with a total sample of 2,894 participants. Measures primarily included the Acceptance and Action Questionnaire (AAQ) [**?**], Acceptance and Action Questionnaire-II (AAQ-II) [**?**], and the Psychological Inflexibility in Pain Scale (PIPS) [**?**, **?**]. Among the 39 included studies (34 RCTs and 5 quasi-experimental designs), global psychopathological symptoms

(k = 16) were the most common outcome measure, followed by depression (k = 9).

Table 1 presents the pooled correlation coefficients among X, M, and Y variables across the 39 studies, all showing high significance. Heterogeneity tests revealed a significant Q statistic (Q = 397.83, p < 0.001), indicating substantial variation in correlation matrices across studies, with I^2 values for all pairwise correlations exceeding 50%, supporting the use of random-effects models. Figure 2 [Figure 2: see original paper] presents the path diagram from Stage 2 TSSEM analysis with psychological flexibility as the mediator. Although the regression coefficient c' (c' = 0.19) remained significant, it was reduced from the original c value (c = 0.25), indicating partial mediation. Sobel tests using correlations and standard errors for X→M and M→Y paths confirmed that psychological flexibility significantly mediated ACT' s effects on mental health outcomes (Z = 4.97, p < 0.001).

3.2.2 Acceptance

Six RCT studies examining acceptance with a total sample of 388 participants primarily used the Chronic Pain Acceptance Questionnaire (CPAQ) [**?**]. Outcome measures included anxiety (k = 3), depression (k = 2), and global assessment (k = 1). All three pooled correlation coefficients were highly significant (see Table 1) with significant heterogeneity (Q = 50.57, p < 0.001) and substantial heterogeneity for acceptance (I^2 = 0.81). In the mediation path model, ACT' s effect on mental health outcomes (c' = 0.04) was significantly reduced from the direct path (c = 0.25), and c' became non-significant. Sobel tests indicated that acceptance significantly mediated the relationship between ACT and mental health outcome changes (Z = 4.76, p < 0.001), demonstrating complete mediation.

3.2.3 Cognitive Defusion

Nine studies (6 RCTs, 3 quasi-experimental) with 569 participants primarily used the Automatic Thoughts Questionnaire (ATQ) [**?**, **?**, **?**, **?**, **?**], Drexel Defusion Scale (DDS) [**?**], White Bear Thought Suppression Inventory (WBSI) [**?**, **?**, **?**], and Avoidance and Fusion Questionnaire for Youth (AFQ-Y) [**?**]. Outcome measures primarily included global psychopathological symptoms (k = 3) and depression (k = 3).

All three pooled correlation coefficients were highly significant (see Table 1) with significant heterogeneity (Q = 83.65, p < 0.001). In the mediation model with cognitive defusion as the mediator, although the Stage 2 path coefficient X→Y (c' = 0.40) decreased from Stage 1 (c = 0.43), the reduction was minimal, with indirect effects accounting for only 10% of total effects. Sobel tests revealed that cognitive defusion did not significantly mediate the relationship between ACT and mental health outcome changes (Z = 1.39, p = 0.17).

3.2.4 Present Moment Awareness

Fourteen RCT studies with 1,613 participants primarily used the Five Facet Mindfulness Questionnaire (FFMQ) [**?**], with some studies using the Kentucky Inventory of Mindfulness Skills (KIMS) [**?**, **?**, **?**], Philadelphia Mindfulness Scale (PMS) [**?**, **?**], and Mindful Attention Awareness Scale (MAAS) [**?**]. Depression ($k = 7$) was the most common outcome measure, followed by global psychopathological symptoms ($k = 6$).

All three pooled correlation coefficients were highly significant (see Table 1) with significant heterogeneity ($Q = 674.31$, $p < 0.001$) and substantial heterogeneity ($I^2 > 89\%$). In the path model with present moment awareness as the mediator, ACT' s effect on mental health outcomes ($c' = 0.21$) decreased significantly from the direct path ($c = 0.30$), though c' remained significant. Sobel tests indicated that present moment awareness significantly mediated the relationship between ACT and mental health outcome changes ($Z = 2.89$, $p = 0.003$), demonstrating partial mediation.

3.2.5 Values

Five RCT studies with 285 participants primarily used the Personal Values Questionnaire (PVQ) [**?**], Valuing Questionnaire (VQ) [**?**], Chronic Pain Values Inventory (CPVI) [**?**, **?**], and Valued Living Questionnaire (VLQ) [**?**, **?**]. Outcome measures included global psychopathological symptoms ($k = 3$) and depression ($k = 2$). All three pooled correlation coefficients were highly significant (see Table 1) with substantial heterogeneity for the mediator ($I^2 = 0.77$), supporting the use of random-effects models. In the path model with values as the mediator, ACT' s effect on mental health outcomes ($c' = 0.08$) decreased significantly from the direct path ($c = 0.16$), and c' became non-significant. Sobel tests revealed that values significantly mediated the relationship between ACT and mental health outcome changes ($Z = 2.16$, $p = 0.03$).

3.3 Mechanisms of ACT Compared to Traditional CBT

Using ACT as the intervention group and traditional CBT as the control group, we examined whether ACT' s mechanisms remained detectable compared to CBT. With psychological flexibility as the hypothesized mediator, 8 studies (7 RCTs, 1 quasi-experimental) with 517 participants used global psychopathological symptoms ($k = 4$) and anxiety ($k = 4$) as outcome measures. The three pooled correlation coefficients showed low heterogeneity ($I^2 < 37\%$) that was non-significant ($Q = 22.15$, $p = 0.39$). In the mediation path model, ACT' s effect on mental health outcomes ($c' = 0.11$) decreased from the direct path ($c = 0.12$), though c' remained significant. The direct effect was 0.12 and the indirect effect was 0.02. Sobel tests indicated significant mediation ($Z = 2.02$, $p = 0.04$), demonstrating that psychological flexibility partially mediated the relationship between ACT and outcomes compared to CBT.

3.4 Testing Mechanisms in Internet-Delivered Interventions

We specifically examined whether psychological flexibility as a hypothesized mediator could be detected in internet-based ACT studies. Six RCT effect sizes (from 4 articles) with 681 participants primarily used depression (k = 5) as the outcome measure. Stage 1 heterogeneity tests showed that all three pooled correlation coefficients were highly significant (see Table 1) with significant heterogeneity (Q = 37.02, p < 0.001). Heterogeneity was low for X and M (I^2 = 18% and 34%, respectively) but high for Y (I^2 = 71%). Stage 2 analysis revealed that in the mediation path model, internet-delivered ACT' s effect on mental health outcomes (c' = 0.11) decreased from the direct path (c = 0.17), though c' remained significant. The direct effect was 0.22 and the indirect effect was 0.06. Sobel tests indicated significant mediation (Z = 3.6, p < 0.001), demonstrating that psychological flexibility partially mediated the relationship in internet-based interventions.

Table 1 presents the TSSEM mediation tests for ACT, including pooled correlations, heterogeneity statistics, statistical power, 95% confidence intervals, and Sobel Z values for each mechanism.

Table 1. TSSEM Mediation Tests for ACT Mechanisms

Mechanism	k	N	r(X,M)	r(M,Y)	r(X,Y)	Q	I^2	Power	95% CI	Sobel Z
Psychological Flexibility	39	2894	0.25***	0.25***	0.19***	397.88***	89%	>0.995	0.19,0.32	Z=4.97, p<0.001
Acceptance	6	388	0.39***	0.53***	0.04	50.57***	81%	>0.995	0.31,0.48	Z=4.76, p<0.001
Cognitive Defusion	9	569	0.27***	0.12	0.40***	83.65***	88%	>0.995	0.14,0.41	Z=1.39, p=0.17
Present Moment	14	1613	0.21***	0.39***	0.21***	674.38***	89%	>0.995	0.23,0.55	Z=2.89, p=0.003
Values	5	285	0.22***	0.33***	0.08	37.02***	77%	>0.995	0.12,0.33	Z=2.16, p=0.03
ACT vs. CBT	8	517	0.23***	0.14*	0.11*	22.15**	37%	0.969	0.02,0.22	Z=2.02, p=0.04
Internet-Based	6	681	0.21***	0.29***	0.11**	37.02***	71%	>0.995	0.14,0.29	Z=3.60, p<0.001

Note: Nfs = fail-safe number; k = number of studies; N = total sample size; p < 0.05, **p < 0.01,** *p < 0.001*

This study used MASEM to systematically test ACT' s hypothesized mechanisms. First, across diverse populations including pain disorders, personality

disorders, depression, anxiety, substance abuse, and work-related burnout, the hypothesized mechanisms of psychological flexibility, acceptance, present moment awareness, and values showed significant mediation, while cognitive defusion did not. Self-as-context and committed action could not be analyzed via MASEM due to insufficient studies. Second, these mechanisms remained evident in internet-delivered interventions, demonstrating generalizability. Third, ACT showed advantages over traditional CBT in its hypothesized mechanisms.

Consistent with previous meta-analytic findings [**?**], ACT demonstrated moderate post-treatment effect sizes (g = 0.45) for changes in its associated process variables compared to traditional CBT. However, it should be noted that most studies in this meta-analysis only measured psychological flexibility. Greater effect sizes for specific mechanisms do not necessarily indicate better treatment outcomes, and current meta-analytic evidence cannot conclude that ACT is more effective than traditional CBT [**?**, **?**, **?**, **?**, **?**]. Nevertheless, as common factors theory suggests a "dodo bird effect" where all effective treatments should be rewarded, this helps clarify common mechanisms across different therapies. Indeed, research comparing ACT to person-centered therapy found equivalent changes in ACT' s proposed psychological flexibility [**?**].

Notably, cognitive defusion did not show significant mediating effects. One possible reason is that among the 9 studies measuring cognitive defusion, 3 used traditional CBT or CT as control groups [**?**, **?**, **?**], and both ACT and traditional CBT may produce cognitive changes. Many researchers consider ACT' s cognitive defusion and traditional CBT' s cognitive restructuring to have similar functions [**?**, **?**], potentially sharing underlying mechanisms [**?**]. Although traditional CBT does not explicitly discuss cognitive defusion, evidence shows that cognitive defusion changes occur not only in ACT but also in traditional CBT [**?**], and ACT similarly changes dysfunctional thoughts emphasized in traditional CBT [**?**]. Cognitive defusion is defined as reducing the literal quality of cognition, resulting in "typically decreasing the believability or attachment to private events" [**?**]—in other words, viewing negative thoughts as behaviors to better separate events from their derived meanings [**?**]. In traditional CBT, this phenomenon is also called metacognitive awareness— "negative thoughts are viewed as mental events that an individual experiences, not as the self" [**?**]. These findings suggest overlap between ACT' s cognitive defusion and traditional CBT' s cognitive restructuring in reducing cognitive believability. How is cognitive believability reduced? Some researchers suggest that cognitive restructuring and acceptance help reduce suppression and psychological avoidance of mental events, a process that includes focusing on, identifying, and interrupting negative thoughts, which may constitute a form of exposure [**?**]. Many ACT exercises, such as word games (word repetition, silly voices, speaking slowly, singing thoughts, word translation), are exposure procedures that bring clients into repeated contact with high-frequency relevant stimuli until the functions evoked by language weaken [**?**]. In short, exposure may be a common mechanism underlying both cognitive defusion and cognitive restructuring.

Limitations of this study: (1) This study focused only on RCT and non-randomized controlled studies; other study types, such as case studies, could provide deeper understanding of how ACT' s mechanisms change during treatment. (2) The included studies varied in participant characteristics, types of mental disorders or psychological problems, specific procedures, and data collection methods. This represents the classic "apples and oranges problem" in meta-analysis. However, the included studies shared the common focus on ACT' s effects on mental disorders or psychological problems, providing the basis for meta-analysis. (3) Theoretically, the six components should be first-order factors, with Hayes using psychological flexibility as an umbrella term for the six mechanisms, suggesting psychological flexibility should be a second-order factor. More complex mechanism models may exist, such as ACT → specific ACT component → psychological flexibility → treatment outcome, or ACT → psychological flexibility → change in specific ACT component → treatment outcome. However, MASEM is a secondary analysis of existing empirical research, and few included studies simultaneously measured both psychological flexibility and the six components, preventing examination of more complex ACT mechanism models. (4) MASEM has inherent limitations. This study reported Sobel tests for mediation, which have been criticized in recent years for assumptions of normality and low statistical power [**?**]. Additionally, common method bias may exist in how original studies measured mediator and outcome variables, potentially affecting our results.

5 Clinical Research Implications

(1) **Comprehensively measure all six core ACT mechanisms**. Current research primarily uses the AAQ and AAQ-II, which tend to measure global psychological flexibility, with less examination of the six specific core mechanisms. Many studies do not measure all six mechanisms, possibly due to measurement inconvenience, as different mechanisms require different instruments. Recently, researchers have developed measures that simultaneously assess all six ACT components [**?**], though their psychometric properties require further validation in clinical research.

(2) **Focus on enhancement of quality of life, not just symptom improvement**. Current ACT research has focused primarily on symptom reduction. Future studies should examine impacts on quality of life enhancement. Some perspectives suggest ACT' s six mechanisms can be grouped into three modules [**?**]: acceptance and cognitive defusion constitute the "open" module, aimed at reducing harmful reactions to thoughts, emotions, and sensations; values and committed action constitute the "engagement" module, focusing on strengthening motivation and increasing meaningful behavior; and present moment awareness and self-as-context primarily promote self-awareness, included in both "open" and "engagement" modules but not specifically emphasized. Among studies included in this meta-analysis, most focused on the "open" module, with less atten-

tion to the "engagement" module. The "engagement" module is critically important. ACT's founder Hayes has repeatedly emphasized that the therapy' s acronym "ACT" should be pronounced as the word "Act" rather than "A-C-T" to highlight the importance of committed action. Moreover, influenced by positive psychology, the dual-factor model of mental health proposes that mental health involves not merely the absence of mental illness but also high levels of well-being [**?**]. Mechanisms focusing on acceptance and cognitive defusion show strong effects in reducing mental disorder symptoms, while values and committed action may be more helpful for enhancing well-being [**?**]. For many symptoms, particularly somatic-related psychological symptoms such as pain disorders that may not be completely eradicated, helping clients seek value-consistent lives while learning to live with symptoms is especially important.

(3) **Adopt RCT designs with multiple measurement points combined with experience sampling methods**. Almost no studies meet requirements for mediator testing in treatment research. Perhaps the greatest challenge in identifying mediators is establishing the causal relationship where changes in the mediator lead to changes in symptoms. Despite over three decades of process research, clear experimental explanations of psychotherapy change mechanisms remain elusive [**?**]. Even in studies designed to examine causal processes of therapeutic change, establishing causality is difficult. First, determining optimal timing and intervals to capture critical points of therapeutic change is challenging, particularly without prior information about the speed and pattern of change. Researchers must balance optimal study design, participant burden, and risks of measurement reactivity from excessive assessment [**?**]. Additionally, research designs typically assume therapeutic change is gradual and linear, yet various studies indicate that change often occurs suddenly rather than gradually during treatment [**?**]. If treatment gains are indeed sudden (e.g., "aha experiences"), capturing these moments and assessing temporal relationships between mechanism changes and symptom changes becomes extremely difficult [**?**]. However, with the development of internet-based interventions, particularly mobile app interventions [**?**], combining experience sampling methods where participants actively report momentary experiences [**?**] to capture sudden treatment gains is becoming increasingly feasible and will help clarify change mechanisms.

(4) **Employ more advanced statistical methods beyond traditional mediation tests**. According to Kazdin' s [**?**] recommendations for testing treatment mediators, most current mechanism studies use the recommended bootstrap method [**?**]. However, some researchers argue that examining pre-post (or follow-up) changes is insufficient for exploring change mechanisms; multiple measurements of both mediator and outcome variables during treatment are needed to examine their change trajectories [**?**]. Very few ACT researchers have measured mechanisms and outcomes after each treatment session and used longitudinal mediation models corre-

sponding to multiple time points. Most existing studies have used mixed-effects regression models, with time, mediator, and outcome variables at Level 1 and individual differences at Level 2, to examine changes in mechanisms and outcomes across treatment sessions [**?**, **?**]. However, newly developed longitudinal mediation analysis techniques [**?**], such as Latent Growth Curve Models (LGCM), Latent Change Score Models, and Multilevel Structural Equation Modeling, should also be considered.

This study used meta-analytic structural equation modeling to test mechanisms in 50 ACT studies, concluding that: (1) the hypothesized mediating effects of psychological flexibility, acceptance, present moment awareness, and values reached statistical significance, whereas cognitive defusion did not; (2) ACT demonstrates advantages over traditional CBT in its hypothesized mechanisms; and (3) these mechanisms remain evident in internet-delivered interventions, indicating generalizability of ACT' s treatment mechanisms.

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Note: Figure translations are in progress. See original paper for figures.