

Bridging Metacognition and Short-Video Addiction: A Network Analysis among Chinese Children and Adolescents

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ABSTRACT: *Short-form video addiction has become a public health concern affecting the cognitive development and mental health of Chinese children and adolescents. This study recruited 1,802 children and adolescents to examine the association network structure between metacognition and short-form video addiction at the item level. Results revealed a "strong cohesion, weak bridging" pattern: the 20 strongest edges were all within-community connections; the average bridge strength of negative metacognitive items was approximately 3.7 times that of positive metacognitive items; and NM_5 ("Short-form videos are fascinating"), NM_1 ("I cannot control the time I spend on short-form video apps"), NM_4 ("Constantly wanting to use short-form video apps has affected my daily life"), and SVAA6 ("I have tried to reduce the time I spend on short-form videos but failed") constituted a statistically indistinguishable bridging core cluster. Among the 35 cross-community non-zero edges, the significant edge rate for negative metacognition ↔ short-form video addiction was 47.6%, whereas not a single edge between positive metacognition ↔ short-form video addiction reached significance. These findings suggest that the bridging between metacognition and short-form video addiction is primarily driven by negative metacognitive beliefs, and that positive metacognition may serve as a distal factor that indirectly influences addiction by activating negative metacognition.*

KEYWORDS— *Short-form video addiction; Metacognitions; Network analysis; Bridge centrality; Children and adolescents*

I. INTRODUCTION

Digital media have become an integral part of contemporary children's and adolescents' daily lives, and the penetration rate of short-form video applications has continued to rise over the past decade. While this trend offers opportunities for entertainment and social interaction, it also carries risks of addiction—short-form video

addiction is gradually becoming a public health issue affecting cognitive development, academic functioning, and mental health [1]-[3]. Against this backdrop, identifying the core cognitive mechanisms of short-form video addiction is of considerable importance for understanding its onset and maintenance processes, and for developing precise intervention strategies accordingly.

1.1 Metacognition and Short-Form Video Addiction

Existing research has noted that short-form video use often occupies substantial fragmented time, that algorithmic recommendation mechanisms continuously provide emotional comfort, that cessation produces pronounced negative affect, and that excessive use has already impaired academic performance, work, and real-life social interaction, with individuals prone to relapse after attempting abstinence [4]. These features closely align with the typical manifestations of behavioural addiction, among which the five dimensions of salience, mood modification, withdrawal, conflict, and relapse have received empirical support, whereas evidence for the tolerance dimension remains insufficient. According to the established components model of addiction, behavioural addiction comprises six core components: salience (the behaviour becomes the most important activity in life, dominating the individual's thinking and affect), mood modification (the behaviour is used to regulate emotional states), tolerance (increasing amounts of the behaviour are required to achieve the same effect), withdrawal (negative affect and physiological reactions occur when the behaviour is stopped or reduced), conflict (conflict between the behaviour and other life domains), and relapse (repeated attempts to reduce the behaviour that end in failure) [5]. Comparing the above manifestations of short-form video use with this model reveals that the occupation of fragmented time corresponds to salience, the emotional comfort provided by algorithmic recommendation corresponds to mood modification, the negative affect following cessation corresponds to withdrawal, the impairment of academic performance, work, and real-life social interaction corresponds to conflict, and the recurrence after attempted abstinence corresponds to relapse. Short-form video addiction is thus not a single-dimensional behavioural problem, but rather a comprehensive addiction pattern encompassing multiple levels of cognition, emotion, behavioural control, and social functioning. This multi-component characteristic also provides a theoretical basis for examining its cognitive maintenance mechanisms from a metacognitive perspective.

In explaining the psychological mechanisms of behavioural addiction, metacognitive theory offers an important analytical framework. According to the Self-Regulatory Executive Function (S-REF) model, the persistence of psychological distress does not stem from cognitive content per se, but is maintained by individuals' beliefs about their own cognition (i.e., metacognitive beliefs) [6]. Existing research has extended this model to the domain of addictive behaviours, distinguishing between two types of beliefs: positive metacognition and negative metacognition. Positive metacognition (e.g., "Scrolling through short-form videos helps me relax") drives the initial initiation of the behaviour, whereas negative metacognition (e.g., "I cannot control my thoughts about scrolling through short-form videos") plays a core role in behavioural maintenance and the sense of losing control [7]. This distinction has been validated in domains such as smartphone addiction, online gaming addiction, and social media addiction.

Within this theoretical framework, researchers have begun to examine the association between metacognitive beliefs and short-form video addiction. A recent systematic review and meta-analysis found that dysfunctional metacognitive beliefs are key cognitive predictors of behavioural addiction, with the effect of negative metacognition significantly stronger than that of positive metacognition [8]. Researchers have developed a Metacognitions about Short-Form Video Use Scale (MSVUS) for Chinese children and early adolescents, finding that the unique contribution of negative metacognition to short-form video addiction was significantly greater than that of positive metacognition, and that network analysis revealed high interconnectedness among negative metacognitive items [9]. Another study using cross-lagged network analysis further confirmed that the strongest longitudinal bridging edges existed between negative metacognition about mobile phone use and withdrawal and relapse symptoms, suggesting that negative metacognitive beliefs play a core role spanning symptom dimensions during the maintenance stage of addiction [10].

However, existing research has an important methodological limitation: most studies examine the relationship between total metacognition scores and total addiction scores at the latent variable level, and cannot answer the question of which specific beliefs within the metacognitive system form direct conditional dependencies with which specific symptoms of the addictive system. Network analysis provides an appropriate analytical tool for this purpose. It does not presuppose a unidirectional relationship in which "metacognition causes addiction" or "addiction alters metacognition," but rather treats metacognitive beliefs and addictive symptoms as nodes within a mutually activating cognitive-behavioural system, revealing the structure of cross-system connections by estimating conditional dependencies among items. In addition, bridge centrality indices can further identify nodes that play a key role in cross-construct connections, providing a basis for the selection of intervention targets.

1.2 Purpose of the Present Study

This study aims to employ network analysis to examine the item-level association structure between metacognition and short-form video addiction. Specifically, it addresses three questions: (1) to estimate the cross-construct network between metacognition and short-form video addiction, revealing the conditional dependency structure at the item level; (2) to compute bridge centrality indices and identify bridging hub nodes in the cross-construct network, with the specific hypotheses that (a) the bridge strength of negative metacognitive items is significantly higher than that of positive metacognitive items, and (b) stable cross-community connections exist between negative metacognitive items and addictive symptoms, whereas no such connections exist between positive metacognitive items and addictive symptoms; and (3) to examine, based on Griffiths' components model of addiction, the distribution patterns of bridging hub nodes across addiction symptom dimensions, thereby providing a theoretical basis for the selection of intervention targets.

II. METHODS

2.1 Participants

Using convenience sampling, 1,888 students from Grades 4 to 9 were recruited. After excluding those who had never used short-form video applications ($n = 86$), the final valid sample comprised 1,802 participants. Their ages ranged from 9 to 16 years, with a mean age of 12.09 years ($SD = 1.65$).

2.2 Measures

2.2.1 Metacognitions about Short-Form Video Use Scale

The Short-Form Video Use Metacognition Scale developed by Xie and Liu (2026) was employed [9]. It comprises two dimensions (positive metacognition and negative metacognition) and a total of 10 items. Items are rated on a 4-point Likert scale ranging from 1 (disagree) to 4 (strongly agree). In the present study, Cronbach's α coefficients were .90 for the positive metacognition subscale and .81 for the negative metacognition subscale.

2.2.2 Short-Form Video App Addiction Scale

The Short-Form Video Overuse Scale, developed by Choi and Lim (2016) and translated by Zhang et al. (2019) [11-12], was employed. This scale is unidimensional and comprises six items. Items are rated on a 7-point Likert scale ranging from 1 (completely disagree) to 7 (completely agree), with higher scores indicating a greater tendency toward short-form video addiction. In the present study, Cronbach's α for this scale was .83.

2.3 Procedure

Participants were recruited from primary and secondary schools in Hunan and Jiangxi Provinces, China (two secondary schools and six primary schools). Approval was obtained from the schools, students, and their parents. Questionnaires were distributed collectively during class time and collected on-site by the researchers.

2.4 Data Analysis

All analyses were conducted in R 4.6.1. Correlation heatmaps were generated using the `corrplot` package. Network estimation and stability checks were performed using the `bootnet` package. Bridge centrality was computed using the `networktools` package. Data wrangling and visualization were carried out using `tidyverse`, `qgraph`, and `ggplot2`. The cross-construct network between metacognition and short-form video addiction was estimated using a regularized partial correlation network (EBICglasso). The network comprised 16 nodes, assigned to three communities based on theoretical constructs: negative metacognition, positive metacognition, and short-form video addiction. A Spearman correlation matrix served as input, with the tuning parameter set to 0.5 and the random seed set to 20260705. Bridge centrality was calculated using the `bridge()` function, with Bridge Strength and Bridge Expected Influence (1-step) as the primary indices.

Network parameter stability was assessed using 1,000 non-parametric bootstrap resamples (case resampling). The stability of bridge indices was evaluated using the correlation stability (CS) coefficient, with $CS \geq .25$ considered acceptable and $CS \geq .50$ considered stable. Edge weight stability was assessed using the 95% confidence interval for each edge and the edge-weight CS coefficient. An edge was considered significant at $\alpha = .05$ if its 95% CI did not include zero. Non-zero edges were categorized by community pair into four types: within-community edges, negative metacognition $\leftrightarrow$ short-form video addiction, positive metacognition $\leftrightarrow$ short-form video addiction, and negative metacognition $\leftrightarrow$ positive metacognition. The number of significant

edges and average edge weights were calculated for each category, with a focus on comparing negative metacognition ↔ short-form video addiction against positive metacognition ↔ short-form video addiction. Network structure plots were generated using qgraph, with nodes colored by community and scaled by bridge strength. Visualizations of bridge strength, edge weight stability, and significant cross-community edges were produced using ggplot2.

III. RESULTS

3.1 Correlation Analysis of the Main Variables

Correlation analysis among the main variables (Figure 1) showed that both positive and negative metacognition were significantly positively correlated with short-form video addiction. The two metacognition dimensions were also significantly positively correlated with each other.

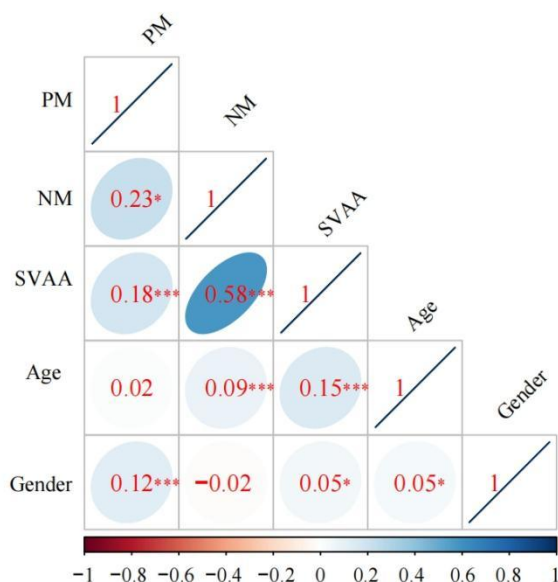


Fig. 1. Heatmap of the correlation analysis

3.2 Network analysis

3.2.1 Network Structure and Edge Weights

The cross-construct network between metacognition and short-form video addiction was estimated using an EBICglasso regularised partial correlation network (Figure 2). The network contained 120 possible edges, of which 68 non-zero edges (56.7%) were retained after regularisation, including 65 positive and 3 negative edges. In terms of community distribution, there were 33 within-community edges (8 in the negative metacognition group, 10 in the positive metacognition group, and 15 in the short-form video addiction group) and 35 cross-community edges (21 for negative metacognition ↔ short-form video addiction, 6 for positive metacognition ↔ short-form video addiction, and 8 for negative metacognition ↔ positive metacognition). Notably, all within-group connections were retained in the positive metacognition and short-form video addiction groups (100% of the

theoretical maximum in each case), indicating a high degree of redundancy among the items in these two groups: when partial correlations among items are generally strong, EBICglasso with $\gamma = 0.5$ does not shrink them to zero. In the negative metacognition group, 8 of the 10 theoretical within-group edges were retained, indicating slight differentiation in the internal structure of this group. The mean edge weight of the network was 0.058.

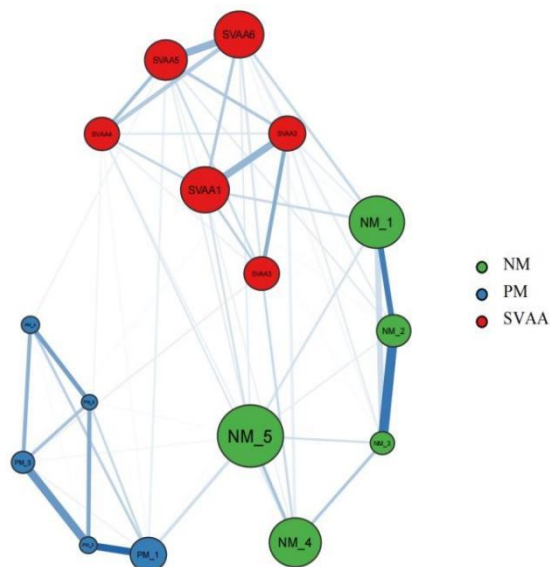


Fig. 2. Cross-construct network of metacognition and short-form video addiction

The three negative edges were PM_3–SVAA3 ($\beta = -0.035$, 95% CI $[-0.062, 0.000]$), PM_3–SVAA2 ($\beta = -0.009$, 95% CI $[-0.036, 0.000]$), and NM_1–SVAA3 ($\beta = -0.007$, 95% CI $[-0.041, 0.000]$). Two of the three negative edges involved PM_3 ("Short-form videos help me control my negative thoughts"), suggesting a weak negative association between the cognitive-escape item of positive metacognition and addictive symptoms. The third involved NM_1 ("I cannot control the time I spend on short-form video apps") and SVAA3 ("Short-form video use has interfered with my social activities"), suggesting a weak negative association between the belief in loss of time control and social interference symptoms. The upper bounds of the confidence intervals for all three negative edges were zero, and none of the negative associations reached significance at $\alpha = .05$.

Ranked by absolute edge weight, the 20 strongest edges were all within-community connections (weight range 0.129–0.474), and the 21st edge was the first cross-community edge (NM_1–SVAA6, $\beta = 0.118$, 95% CI $[0.070, 0.163]$). Notably, this first cross-community edge was precisely the top-ranked significant cross-community edge in Table 3 of Section 3.5, a correspondence that provides edge-level evidence for the subsequent bridging analysis. No negative metacognition $\leftrightarrow$ short-form video addiction, positive metacognition $\leftrightarrow$ short-form video addiction, or negative metacognition $\leftrightarrow$ positive metacognition cross-community edges entered the top 20. The three strongest edges were PM_1–PM_2 ($\beta = 0.474$, 95% CI $[0.418, 0.513]$), NM_2–NM_3 ($\beta = 0.424$, 95% CI $[0.368, 0.475]$), and NM_1–NM_2 ($\beta = 0.403$, 95% CI $[0.345, 0.449]$), all of which were within-community connections. The strongest cross-community edge (NM_1–SVAA6, $\beta = 0.118$) was almost equivalent in strength to the weakest within-community edge (SVAA1–SVAA4, $\beta = 0.129$), indicating that

the bridging function is not carried by weak edges exhibiting a precipitous drop in strength, but rather accumulates from multiple moderate-strength edges comparable in strength to the weakest within-community edges.

3.2.2 Bridge Centrality

Among the 16 nodes (Figure 3), the four with the highest bridge strength were, in order, NM_5 ("Short-form videos are fascinating," $M = 0.389$, 95% CI [0.313, 0.466]), NM_1 ("I cannot control the time I spend on short-form video apps," $M = 0.317$, 95% CI [0.241, 0.398]), NM_4 ("Constantly wanting to use short-form video apps has affected my daily life," $M = 0.289$, 95% CI [0.230, 0.353]), and SVAA6 ("I have tried to reduce the time I spend on short-form videos but failed," $M = 0.270$, 95% CI [0.210, 0.350]). The confidence intervals of these four nodes overlapped, constituting a statistically indistinguishable bridging core cluster.

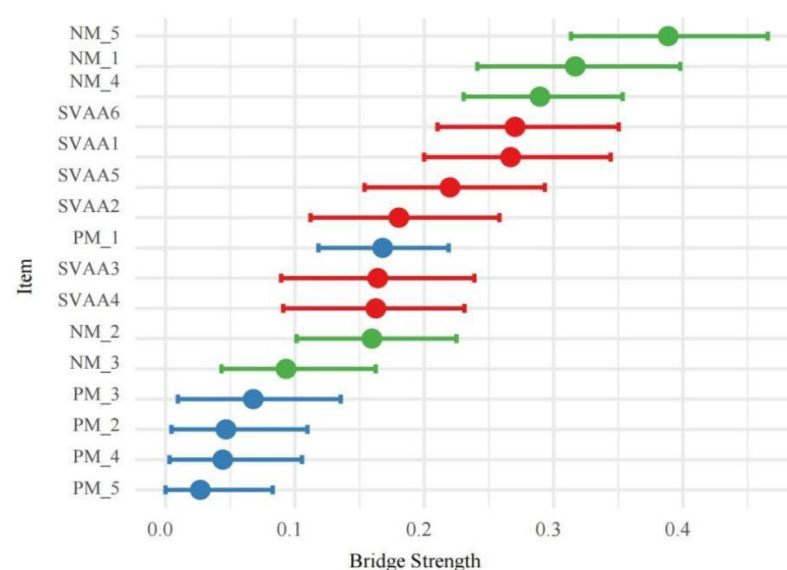


Fig. 3. Bridge strength of each node with 95% bootstrap confidence intervals

At the community level, the average bridge strength of negative metacognitive items ($M = 0.243$) was approximately 3.7 times that of positive metacognitive items ($M = 0.065$), and also exceeded that of short-form video addiction symptom items ($M = 0.207$). The lower bounds of the 95% CIs for NM_5, NM_1, and NM_4 (0.313, 0.241, and 0.230, respectively) were all higher than the upper CI bounds of all items in the positive metacognition group (PM_1 being the highest at 0.219), indicating that the bridge strength of negative metacognitive items was significantly higher than that of positive metacognitive items.

Within the negative metacognition group, the lower bound of the 95% CI for NM_5 (0.313) was higher than the upper bound of the CI for NM_2 ("Once I start using short-form video apps, I cannot stop," $M = 0.160$, 95% CI [0.101, 0.225]), indicating a significant difference at $\alpha = .05$; the difference between NM_4 and NM_2 fell at the boundary of significance (0.230 vs. 0.225). However, the confidence intervals of NM_5, NM_1, and NM_4 overlapped (the overlap between NM_5 and NM_4 was [0.313, 0.353], a width of 0.040, close to the boundary of significance; the overlap between NM_5 and NM_1 was [0.313, 0.398]), indicating that the bridge strengths of these three items were statistically difficult to distinguish. SVAA6 was the only addiction symptom item in the

bridging core cluster, and its bridge strength was indistinguishable from those of NM_5, NM_1, and NM_4. This high bridge strength did not stem from any single strong edge, but rather from multiple moderate-strength edges connecting it to several negative metacognitive items, including significant connections with the belief in loss of time control (NM_1–SVAA6, $\beta = 0.118$), the fascination belief (NM_5–SVAA6, $\beta = 0.057$), and the loss-of-control belief (NM_2–SVAA6, $\beta = 0.057$).

All items in the positive metacognition group had relatively low bridge strength ($M = 0.065$). Among them, PM_3 ("Short-form videos help me control my negative thoughts") had a numerically negative bridge expected influence (EI = -0.024 , 95% CI [-0.063 , 0.028]), but the confidence interval included zero, indicating that this negative association was not statistically significant. This negative value mainly arose from two negative edges between PM_3 and SVAA3 (social interference) and SVAA2 (insomnia) ($\beta = -0.035$ and -0.009), but neither reached significance. PM_1 was the only item in the positive metacognition group with a significantly positive EI (0.164 , 95% CI [0.104 , 0.210]), but its bridge strength was still lower than that of the lowest core item in the negative metacognition group, NM_4 (0.289 , 95% CI [0.230 , 0.353]); the upper CI bound of PM_1 (0.219) was lower than the lower CI bound of NM_4 (0.230), with no overlap, indicating a significant difference. The composition of this bridging core cluster indicates that the bridging between metacognition and addictive symptoms is primarily borne jointly by three core beliefs of negative metacognition (NM_5 "fascination," NM_1 "loss of time control," and NM_4 "life conflict") and one addiction behavioural feature (SVAA6 "loss of control"), whereas positive metacognitive beliefs and the remaining addiction symptom items occupy peripheral positions in the bridging structure.

3.2.3 Stability of Bridge Indices

The stability of bridge centrality indices was tested using 1,000 non-parametric bootstrap iterations (case resampling, Figure 4). Bootstrap stability testing was conducted only for Bridge Strength and Bridge Expected Influence, as these two indices are the most theoretically meaningful in cross-construct networks. Bridge Betweenness and Bridge Closeness generally exhibit insufficient stability in comparable studies (with CS coefficients often below 0.25) and were therefore not included in substantive interpretation. The correlation stability (CS) coefficient was 0.75 for both bridge strength and bridge expected influence.

The lower bounds of the EI confidence intervals for all negative metacognitive items and addiction symptom items were greater than zero, indicating that the bridging function of these nodes was stable across bootstrap resamples. In the positive metacognition group, PM_1 had a significantly positive EI (0.164 , 95% CI [0.104 , 0.210]), whereas the EI confidence intervals for the remaining four items (PM_2, PM_3, PM_4, and PM_5) all included zero, indicating that their bridging function was not statistically significant. Given that the CS coefficient reached 0.75, the ranking of bridge strength could be substantively interpreted.

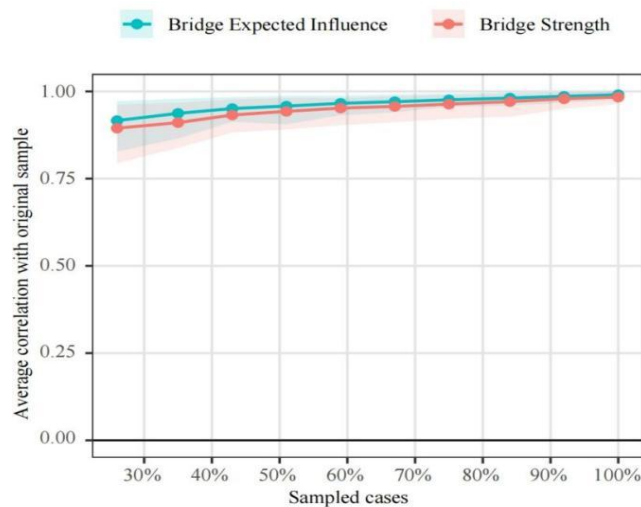


Fig. 4. Bootstrap stability of bridge centrality

3.2.4 Stability of Edge Weights

The same 1,000 non-parametric bootstrap procedure was used to test the stability of edge weights. The CS coefficient for edge weights was 0.75, reaching the highest level tested in bootstrap stability assessment, indicating that the ranking of edge weights was as stable as that of bridge strength. The weight estimates for the 68 non-zero edges were generally stable, and their bootstrap 95% confidence intervals are shown in Figure 5.

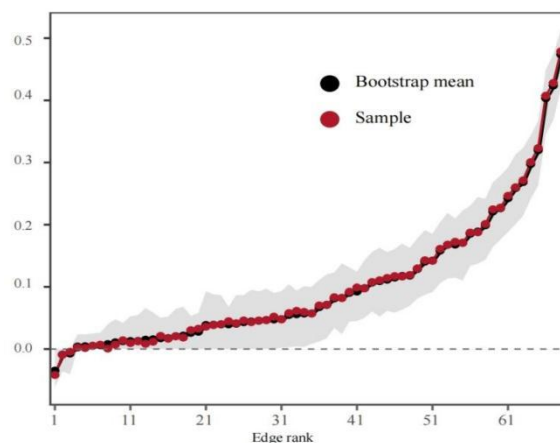


Fig. 5. Bootstrap 95% confidence intervals for edge weights

Note. 68 edges, sorted by weight in descending order.

In terms of the distribution of edge weights, the 20 strongest edges (all within-community connections, weights 0.129–0.474) had relatively narrow confidence intervals that did not include zero, indicating that within-community connections were estimated very stably. The middle-range edges (edge numbers 21–50, weights between 0.03 and 0.12) had relatively wide confidence intervals, with the lower CI bounds of some edges approaching zero. The later edges (edge numbers 51–68, weights close to zero) had wide confidence intervals, some of which included zero. The upper bounds of the confidence intervals for the three negative edges were all

zero, and the negative associations did not reach significance at $\alpha = .05$.

3.2.5 Significance of Cross-Community Edges

Of the 35 cross-community non-zero edges, only 11 reached significance (95% CI excluding zero), accounting for 31.4% of all cross-community non-zero edges (Figure 6). By community pair, the significant edge rate was $10/21 = 47.6\%$ for negative metacognition $\leftrightarrow$ short-form video addiction, $1/8 = 12.5\%$ for negative metacognition $\leftrightarrow$ positive metacognition, and $0/6 = 0\%$ for positive metacognition $\leftrightarrow$ short-form video addiction. The bridging core cluster nodes identified in Section 3.2.2 (NM_5, NM_1, NM_4, and SVAA6) were precisely the main endpoints of the significant cross-community edges, a correspondence that further supports the robustness of the bridge centrality results. Complete information on the 11 significant cross-community edges is presented in Table 3, and their bootstrap 95% confidence intervals are shown in Figure 6.

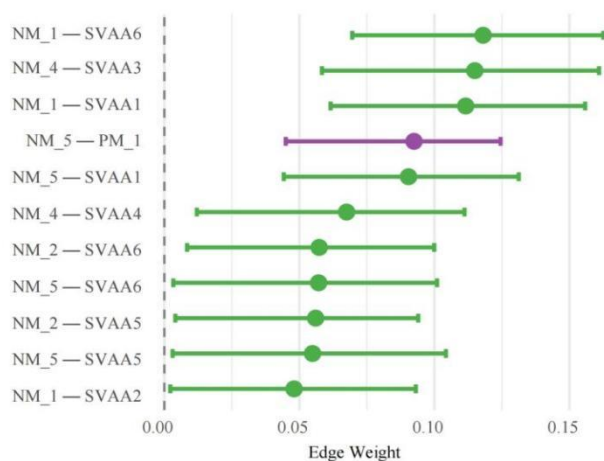


Fig. 6. Bootstrap 95% confidence intervals for 11 significant cross-community edges

The six non-zero edges for positive metacognition $\leftrightarrow$ short-form video addiction all had weights between 0.01 and 0.04, with 95% CIs touching zero, indicating that not only was there a lack of significant direct association between positive metacognition and addictive symptoms, but the point estimates themselves were close to zero. Among these six edges, PM_1–SVAA5 ($\beta = 0.040$, 95% CI [0.000, 0.068]) and PM_4–SVAA5 ($\beta = 0.028$, 95% CI [0.000, 0.058]) were both positive, involving weak associations between "reducing worry/no longer feeling anxious" and withdrawal anxiety; PM_3–SVAA3 ($\beta = -0.035$, 95% CI [-0.062, 0.000]) and PM_3–SVAA2 ($\beta = -0.009$, 95% CI [-0.036, 0.000]) were both negative, involving weak negative associations between "controlling negative thoughts" and social interference and insomnia.

The three strongest significant cross-community edges were NM_1–SVAA6 ($\beta = 0.118$, 95% CI [0.070, 0.163]), NM_4–SVAA3 ($\beta = 0.115$, 95% CI [0.058, 0.161]), and NM_1–SVAA1 ($\beta = 0.112$, 95% CI [0.062, 0.156]). These three edges correspond respectively to three symptom dimensions: loss of control (NM_1 "I cannot control the time I spend on short-form video apps" $\leftrightarrow$ SVAA6 "I have tried to reduce the time I spend on short-form videos but failed"), conflict/functional impairment (NM_4 "Constantly wanting to use short-form video apps has affected my daily life" $\leftrightarrow$ SVAA3 "Short-form video use has interfered with my social activities"), and salience

(NM_1 ↔ SVAA1 "Due to short-form video use, I have difficulty focusing on my studies or work"). NM_4 and SVAA3 both conceptually involve interference of short-form video use with daily functioning, and the association between them may partly stem from content overlap; future research could examine the independence of this association by further differentiating item wording.

NM_1 simultaneously connected loss of control (SVAA6: failed reduction, $\beta = 0.118$) and salience (SVAA1: difficulty focusing on studies/work, $\beta = 0.112$), and was also significantly but more weakly associated with the physiological functioning dimension of conflict/functional impairment (SVAA2: insomnia; $\beta = 0.048$, 95% CI [0.002, 0.093]). The lower CI bound of the latter was close to zero, indicating that although this association was statistically significant, its strength was far weaker than the previous two edges. The bridging function of NM_1 was mainly concentrated in the two dimensions of loss of control and salience, with a relatively limited bridging role in physiological consequences.

NM_5 appeared in 4 significant edges, 3 of which were negative metacognition ↔ short-form video addiction edges (NM_5–SVAA1, NM_5–SVAA6, NM_5–SVAA5) and 1 of which was a negative metacognition ↔ positive metacognition edge (NM_5–PM_1). NM_1 appeared in 3 significant edges, all of which were negative metacognition ↔ short-form video addiction edges; NM_4 appeared in 2 significant edges, both of which were negative metacognition ↔ short-form video addiction edges. This is consistent with the top three rankings of bridge strength (NM_5, NM_1, and NM_4).

In terms of the magnitude of edge weights, the strongest cross-community edge (NM_1–SVAA6, $\beta = 0.118$) was only one quarter of the strongest within-community edge (PM_1–PM_2, $\beta = 0.474$), but was comparable in strength to the weakest within-community edge (SVAA1–SVAA4, $\beta = 0.129$). The mean absolute weight for negative metacognition ↔ short-form video addiction was 0.050, whereas that for positive metacognition ↔ short-form video addiction was only 0.026, and the mean signed weight of the latter's six non-zero edges was only 0.011, close to zero. The significant edge rate between negative metacognition and addictive symptoms (10/21 = 47.6%) was far higher than that between positive metacognition and addictive symptoms (0/6 = 0%).

IV. DISCUSSION

This study employed network analysis to examine the item-level association structure between metacognition and short-form video addiction. Results indicated that bridging function was primarily borne by negative metacognitive beliefs, whereas no stable direct association existed between positive metacognitive beliefs and addictive symptoms. This finding provides item-level evidence for understanding the cognitive maintenance mechanisms of short-form video addiction and offers a basis for the precise selection of intervention targets.

4.1 The Relationship between Metacognition and Short-Form Video Addiction

The core finding of this study is that, in the cross-construct network between metacognition and short-form video addiction, bridging function is primarily borne by negative metacognitive beliefs. No stable direct association exists between positive metacognitive beliefs and addictive symptoms. This pattern is highly consistent with the explanatory framework of the Self-Regulatory Executive Function (S-REF) model for addictive behaviours [6]. According to this model, the persistence of psychological distress does not stem from

cognitive content per se. It is maintained by the cognitive-attentional syndrome activated by metacognitive beliefs [7]. In addictive behaviours, positive and negative metacognition play distinct roles. Positive metacognition drives the initial initiation of the behaviour. Negative metacognition—particularly beliefs about the uncontrollability of cognition—plays a core role in behavioural maintenance and the sense of losing control [7]. A recent study of Chinese children and early adolescents likewise found that the unique contribution of negative metacognition to short-form video addiction was significantly stronger than that of positive metacognition [9].

This study found that the four nodes with the highest bridge strength were, in order, NM_5 ("Short-form videos are fascinating"), NM_1 ("I cannot control the time I spend on short-form video apps"), NM_4 ("Constantly wanting to use short-form video apps has affected my daily life"), and SVAA6 ("I have tried to reduce the time I spend on short-form videos but failed"). Together, these four nodes constituted a statistically indistinguishable bridging core cluster. Notably, NM_5 (fascination) ranked first. In contrast, NM_2 ("Once I start, I cannot stop") and NM_3 ("Short-form videos make me unable to control myself"), which directly measure behavioural loss of control, exhibited relatively lower bridge strength. This dissociation suggests that, among children and adolescents, the hub bridging the metacognitive and addictive symptom systems is not the retrospective belief "I have already lost control." Rather, it is the attractiveness appraisal "This thing fascinates me." "Short-form videos are fascinating" is a cognitive-affective hybrid item. It encompasses both an awareness of short-form video attractiveness and a passive state of being attracted. It enters the addiction cycle earlier than purely behavioural loss-of-control beliefs. Individuals do not need to lose control first in order to find it fascinating; rather, because they find it fascinating, they are more likely to lose control. This is consistent with the view in desire thinking theory that positive metacognition precedes negative metacognition [13].

Furthermore, this study found that another key node in the bridging core cluster was NM_1 ("I cannot control the time I spend on short-form video apps"). NM_1 appeared in three significant cross-community edges. These connected respectively loss of control (NM_1–SVAA6), salience (NM_1–SVAA1), and the physiological functioning dimension of conflict/functional impairment (NM_1–SVAA2). The first two edges were far stronger than the third. This indicates that the bridging function of NM_1 is mainly concentrated in behavioural loss of control and cognitive interference. A previous cross-lagged panel network study found that the strongest longitudinal bridging edges existed between negative metacognition about mobile phone use and withdrawal and relapse symptoms [10]. This is consistent with the strong bridging edge between NM_1 and SVAA6 (loss of control) in this study. It suggests that the bridging relationship between the belief in loss of time control and behavioural control failure is similarly robust in longitudinal data.

In contrast to negative metacognition, all items in the positive metacognition group had relatively low bridge strength. None of the six non-zero negative metacognition ↔ positive metacognition edges was significant. The mean signed weight was only 0.011, close to zero. This result does not support the hypothesis that positive metacognition directly drives addiction. A more reasonable explanation is that positive metacognition is a distal initiator of addiction. It indirectly influences addiction by activating negative metacognition, rather than directly driving addictive behaviour. This is consistent with the S-REF proposition that positive metacognition drives behavioural initiation while negative metacognition drives behavioural maintenance [7]. The edge between NM_5

and PM_1 ("Short-form videos reduce my worries") was the only significant negative metacognition ↔ positive metacognition cross-community edge in this study. This indicates that a stable cognitive cluster is formed between the "fascination" belief and the "stress relief" expectancy. It is consistent with the proposition in desire thinking theory regarding the transition from positive to negative metacognition [13].

The above node-level findings are embedded within a more macro-level network structural feature. The 20 strongest edges were all within-community connections. Cross-community edge weights were generally low. The strongest cross-community edge (NM_1–SVAA6) was only one quarter of the strongest within-community edge. This magnitude difference indicates that the bridging between metacognition and short-form video addiction is not driven by a few strong edges. It is formed by the cumulative effect of multiple moderate-strength edges. Previous research has likewise found that cross-construct edges (between metacognitive beliefs and problematic mobile phone use symptoms) generally have lower weights than within-construct edges [10].

From the perspective of Griffiths' components model of addiction, the three cross-community edges with the highest bridge strength involved loss of control (NM_1–SVAA6), conflict/functional impairment (NM_4–SVAA3), and salience (NM_1–SVAA1). Existing longitudinal research has also found that negative metacognition has the strongest association with withdrawal and relapse symptoms [10]. Positive metacognition about desire thinking, by contrast, is associated with tolerance and relapse symptoms. Combined with the findings of this study, negative metacognition primarily bridges with the cognitive-behavioural control dimensions of addiction (salience, loss of control, conflict). Its bridging with physiological consequence dimensions is weaker. This pattern is concentrated in SVAA6. SVAA6 (loss of control) was the only addiction symptom item in the bridging core cluster. Its bridge strength was indistinguishable from those of NM_5, NM_1, and NM_4. This high bridge strength did not stem from any single strong edge. Rather, it arose from multiple moderate-strength edges connecting it to several negative metacognitive items. Repeated failed control attempts are not only a behavioural consequence of addiction. They also serve as an active bridging node between metacognitive beliefs and addictive symptoms. SVAA6 simultaneously connects the belief in loss of time control and the fascination belief. It therefore occupies a key position in the metacognition–addiction cycle. This finding provides a clear direction for the selection of intervention targets.

4.2 Research implications

First, intervention targets should shift from "positive expectancies" to "negative metacognition." This study found no stable direct association between positive metacognition and addictive symptoms, whereas negative metacognition served as the bridging hub. This suggests that interventions for short-form video addiction in children and adolescents should focus not on correcting positive expectancies such as "scrolling through short-form videos helps me relax," but rather on challenging negative metacognitive beliefs such as "I cannot control myself," "Short-form videos are fascinating to me," and "It has already affected my daily life." Cognitive restructuring techniques from cognitive behavioural therapy that target belief systems—such as identifying evidence for loss-of-control beliefs, testing their validity, and developing alternative beliefs—may more directly sever the metacognition–addiction link than psychoeducation targeting positive expectancies.

Second, the "fascination" belief warrants particular attention. NM_5 ("Short-form videos are fascinating") was the node with the highest bridge strength and the only endpoint of a significant NM ↔ PM cross-community edge. This result suggests that, among children and adolescents, the hub bridging the metacognitive and addictive systems is not the retrospective belief "I have already lost control," but rather the attractiveness appraisal "This thing fascinates me." Interventions should pay particular attention to children's and adolescents' metacognitive appraisals of short-form video attractiveness, helping them recognise the attentional design mechanisms of short-form videos (e.g., algorithmic recommendation, infinite scrolling, and immediate feedback), thereby transforming "fascination" from a mysterious, uncontrollable experience into an understandable, analysable consequence of product design. This may help weaken the bridging function of NM_5.

Third, interventions should simultaneously target multiple cross-system connections rather than a single belief. Network analysis showed that the bridging function is formed through the accumulation of multiple moderate-strength edges, rather than being driven by a few strong edges. This implies that interventions targeting a single belief or symptom may have limited effectiveness. A more effective intervention programme may need to simultaneously address three core beliefs—NM_5 (fascination), NM_1 (loss of time control), and NM_4 (life conflict)—as well as the multiple connections between them and SVAA6 (loss of control), SVAA1 (salience), and SVAA3 (social conflict). Among these, NM_1 simultaneously connects loss of control (SVAA6) and salience (SVAA1), making it an intervention target spanning symptom dimensions; interventions targeting the belief in loss of time control may simultaneously improve both the behavioural control and cognitive focus symptom dimensions.

4.3 Limitations

First, the cross-sectional design precludes determining the direction of causality. This study used cross-sectional data to estimate the network and cannot establish the temporal ordering between negative metacognition and short-form video addiction. Edges in the network represent conditional dependencies rather than causal relationships. Negative metacognition may be a cause of addiction (the cognitive vulnerability model), a consequence of addiction (behavioural consequence feedback), or the two may form a bidirectional reinforcement loop. Future research could collect data at multiple time points and test cross-lagged paths between negative metacognition and addictive symptoms, thereby clarifying the directionality of the bridging relationships.

Second, the item categorisation was based on theoretical construct mapping rather than validation of the original scale structure. The six short-form video addiction items were categorised according to Griffiths' components model of addiction, in which SVAA2 (insomnia) and SVAA3 (social interference) jointly correspond to the conflict/functional impairment dimension, while the mood modification dimension was borne by positive metacognitive items. In addition, SVAA2 and SVAA3 both conceptually involve interference of short-form video use with daily functioning, and their associations with negative metacognition may partly stem from content overlap. Future research could examine the reasonableness of this categorisation through confirmatory factor analysis and test the independence of key associations by further differentiating item wording.

Third, differences among the nodes in the bridging core cluster were not significant, and sample representativeness was limited. The bridge strength confidence intervals of the four nodes—NM_5, NM_1, NM_4, and SVAA6—overlapped, constituting a statistically indistinguishable bridging core cluster. Therefore, this study cannot assert that NM_5 is the "most important" bridging node; it can only state that these four nodes jointly bear the bridging function. Furthermore, the sample comprised Chinese children and adolescents, and generalisation of the results to other age groups or cultural contexts should be made with caution—social norms, parental attitudes, and availability of short-form video use may differ across cultural contexts, potentially affecting the association patterns between metacognition and addiction. Future research could increase statistical power for detecting differences among nodes through larger sample sizes or more precise measurement, and conduct cross-cultural comparisons to test the robustness of the findings.

V. CONCLUSION

This study employed network analysis to examine the item-level association structure between metacognition and short-form video addiction among Chinese children and adolescents, revealing a "strong cohesion, weak bridging" network pattern: the metacognition and short-form video addiction systems each formed tightly connected internal clusters, whereas cross-system connections were borne by the accumulation of multiple moderate-strength edges, with bridging function primarily driven by negative metacognitive beliefs. Specifically, the average bridge strength of negative metacognitive items was higher than that of positive metacognitive items; NM_5 ("Short-form videos are fascinating"), NM_1 ("I cannot control the time I spend on short-form video apps"), NM_4 ("Constantly wanting to use short-form video apps has affected my daily life"), and SVAA6 ("I have tried to reduce the time I spend on short-form videos but failed") constituted a statistically indistinguishable bridging core cluster, within which SVAA6 was the only addiction symptom item. Not a single edge between positive metacognition and addictive symptoms reached significance, suggesting that positive metacognition is not a direct driver of addiction but may be a distal factor that indirectly influences addiction by activating negative metacognition. These findings support the proposition of the S-REF model that "negative metacognition drives behavioural maintenance," and suggest that interventions for short-form video addiction in children and adolescents should shift focus from correcting "positive expectancies" to challenging "negative metacognitive beliefs." In particular, interventions targeting the NM_5 "fascination" belief—helping adolescents recognise the attentional design mechanisms of short-form videos—may help weaken the hub function of the bridging core cluster, while interventions should simultaneously address multiple moderate-strength cross-system connections rather than targeting a single belief.

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