

# Relationship between Sluggish cognitive tempo and Attention Deficit Hyperactivity Disorder in children: Current status and perspective

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**Introduction:** Attention Deficit Hyperactivity Disorder (ADHD) is a neurobiological disorder arising during childhood, involving a pattern of attention deficit, hyperactivity and/or impulsivity. ADHD has negative consequences for young people suffering this condition. Recently it has been proposed that Slow Cognitive Time (SCT) may be a different disorder than ADHD, a similar disorder or they both may co-exist. **Objective:** To perform a narrative review of the medical literature, seeking to collect useful information regarding the relationship between SCT and ADHD, and its impacts on academic performance. **Methodology:** topic reviews, systematic reviews, meta-analyses, clinical trials, and follow-up studies were identified in English and Spanish with no time limit, including epidemiological and clinical aspects, factors associated with hyperactivity/impulsivity, attention deficit, cognitive and executive functions. **Results:** the relationship between SCT and ADHD is very complex. Some scientific research states these are the same disorder or they may co-exist. It is also suggested that high levels of SCT and ADHD could be part of a new attention disorder; however, more research is needed to verify its association with ADHD. **Conclusion:** despite efforts to improve understanding, evaluation, diagnosis, and treatment of ADHD, there are still issues to be solved, being probably evaluation and diagnosis some of the greatest dilemmas.

**Key words:** Slow Cognitive Time, ADHD, disorder, dimension

## INTRODUCTION

ADHD is one of the most diagnosed disorders in children and adolescents, in children/adolescents clinics, whose global prevalence is ranging between 8 to 12%<sup>(1-3)</sup>. In Chile prevalence rates report 6.2% in students (Chilean Ministry of Health, 2008). Risk factors for children with ADHD for the disorder to linger on are unknown, although these have been linked with late treatment, severity of the condition and psychiatric comorbidities, such

as personality disorders, among others<sup>(5)(6)</sup>. ADHD causes negative/ adaptation consequences in children having such condition, in their families, at schools, in the society, on sanitary costs. These reasons, among others, support the research not only from the infant psychopathology, but also from the social/educational scenario. According to the DSM-5 (diagnosis/statistic Manual of mental disorders ) ADHD is a chronic neurobiological disorder, with evolving symptoms and probable genetic transmission, affecting between 5 to 10% of infant popula-

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tion, even reaching till adulthood in 60% of all cases<sup>(7)</sup>.

DSM–5 classifies ADHD in three subtypes: combined type (the child has two factors), with inattentive predominance (the child only meets the criteria for inattentive behavior) with hyperactive/impulsive predominance (the child only meets the criteria for hyperactivity/impulsivity conducts). Despite the efforts aimed to improve understanding, evaluation, diagnosis, and ADHD treatment, still there are some pending issues, being probably one of the biggest dilemmas<sup>(7)</sup> that of diagnosis and evaluation.

ADHD requires a clinical diagnosis. Still there are no objective tests valid enough for such purposes, so a diagnostic structure, based on the existence of two factors encompassing ADHD dimensions had to be used: i.e., inattentive behavior and hyperactivity/impulsivity conducts. During the last few years, various studies have been made on ADHD and coexistence of other pathologies. It has been described that a person with ADHD has six times more probability to suffer another psychiatric disorder than the rest of the population<sup>(8)</sup>. 80% of all ADHD cases have comorbidity with others disorders. According to this scenario, the problem would be to consider a possible attention disorder separated from combined ADHD, being a key aspect presence or absence of hyperactivity/impulsivity conducts<sup>(9)</sup>.

Despite inattention criteria are the same for combined ADHD than for Inattentive ADHD (the presence of higher or lower hyperactivity/impulsivity makes a difference in the diagnosis), currently many studies support the possible existence of a disorder, or at least a pure attentional dysfunction<sup>(10)</sup>. The debate about the existence of a pure attentional dysfunction has created opposite points of view. On the one hand there are those who believe that inattentive behavior in ADHD may be a disorder different from SCT; on the other hand, there are those who believe if there is a pure inattention/concentration disorder, probably it is made up of various conducts, although related with those of ADHD inattention. From this point of view, various investigations support SCT presence to talk about a very concrete type of child: slow thinking and slow motor behavior, normal intelligence and conduct, with an excessively fluc-

tuating level of concentration, unfocused and sunk into a dreamy state<sup>(11–14)</sup>.

In this sense, even though comorbidity among disorders is usual, there is a high relationship between SCT and ADHD, specifically with the inattentive subtype of such disorder (ADHD–IN). Estimations consider that between 30 to 59% of patients diagnosed with ADHD–IN have SCT symptoms; therefore, SCT could affect cognitive/executive functions in children<sup>(15–19)</sup>. During the last few years an increasing interest on the evaluation/detection modes of SCT symptoms has arisen. Before the emerging testing in non clinical fields, i.e. formal educational areas, what is the actual SCT/TADH relationship is still to determined, and what are the social problems arising from this. It is also necessary to know if this is a disorder that predicts anxiety and depression or it is simply related with the latter.

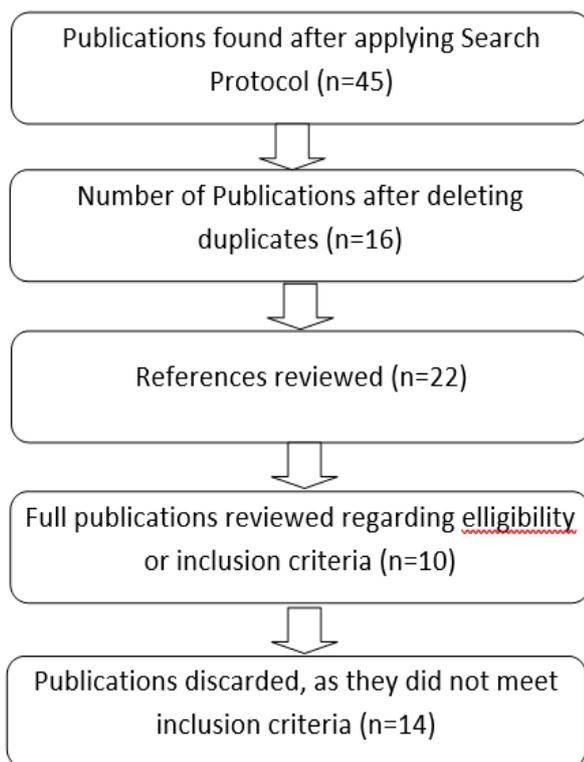
## **METHODOLOGY**

In March 2019 a systematic literature search was made in the data base of Web of Science, PubMed Scopus, both in English and Spanish, about reports published till 2019, and relevant information on SCT/ADHD, using the following search engines with Boolean operators “AND – OR”: “sluggish cognitive tempo”, “attention deficit”, “hyperactivity disorder”, “clinical trials”, “epidemiological cognitive and executive functions. During the works search, studies on a single case, other systematic reviews or works not presenting an experimental design were excluded. The information of the chosen works was transferred into a Microsoft Word document, where the following information was gathered: title, authors, year of publication, objectives, size of the sample and findings between SCT and ADHD (*Figure 1*).

## **RESULTS**

### **Conceptualization of Sluggish Cognitive Tempo**

The study of the SCT, as a construct was found in most ADHD disorders investigations. Given the clear association between SCT and ADHD, a constant/increasing interest to find out whether SCT is a construct empirically different,

**Figure 1.** Phases of systematic review

with its own dimensions and differentiated from ADHD or not, and also to learn about its operation and psychosocial impact<sup>(20)</sup>. There are various opinions about the definition of SCT dimensions, its functions, its description of clinical usefulness, although, most research has been focused on SCT review and its evolution<sup>(21–23)</sup>. Among the most usual features present in this group of subjects are: slow execution of tasks, forgetful, drowsy, daydreaming, absent minded, unmotivated, usually living in another world, confused, having a low performance in some neuropsychological test, low scores when measuring executive functions, reduced alertness, irregular orientation<sup>(24)</sup>.

Because of all the foregoing, SCT is associated to the inattention factor of ADHD, with a lack of hyperactivity and impulsivity<sup>(17)</sup>. The research has been rather focused on SCT as a group of symptoms different from ADHD<sup>(20)</sup>. Authors, such as Barkley et al.<sup>(9)</sup> argue that SCT may be a psychiatric disorder on its own, separated from ADHD, with a prevalence rate –estimated among young people– of 5 – 6%. Despite there are various investigations focused on attention difficulties and on ADHD, few in-

vestigation works –during the last years– have been focused on SCT, although results are encouraging, it is necessary to move forward on symptomatological aspects, such as: comorbidity, evolution, neural correlate, associated risks. On the other hand, despite the importance of the research and the findings, there is still a need to agree on criteria to recognize and validate SCT, highlighting differences between SCT and TDAH9. Several studies have reported that TLC dimension is different from the inattention symptoms<sup>(25)</sup>.

### Symptomatology for Sluggish Cognitive Tempo

One of the main problems found when studying TLC dimension is the lack of reliability and validity of the construct. The most significant finding has been obtained by using the confirmatory factor analysis, accepting a three-factor model which allows to differentiate inattention symptoms, hyperactivity–impulsivity, and SCT. Besides, high correlations between ADHD and those of inattention were found; however, these are moderate when compared with hyperactivity–impulsivity, assuming the existence of SCT construct associated to inattention described in DSM–4 for ADHD<sup>(26)(27)</sup>. On the other hand, SCT symptoms were confirmed to be a factor different from the dimensions of inattention symptoms and hyperactivity of ADHD, thus emerging SCT as a separate construct<sup>(28–30)</sup>. Regarding validity of the construct, a study by Lee et al.<sup>(31)</sup> states the existence of 8 conducts describing SCT symptoms, showing an adequate convergent/discriminate validity. Therefore, even though the statistic validity of the construct seems to be proved, its clinical diagnostic and usefulness still has not been proved<sup>(14)</sup>.

This distinctive feature of SCT and ADHD symptoms, is also stated in direct observation studies of children during the tests execution in a school environment<sup>(32)</sup>, as well as in USA population<sup>14</sup> in a wide sampling of college students<sup>(22)</sup>. On the other hand, SCT symptoms identify a group of children/adolescents, even within samples with inattentive ADHD<sup>(33)(34)</sup>; however, results in this type of research have not been so strong or numerous, as when SCT groups are selected from regular population or other specific samples for SCT<sup>(35)</sup>.

### **Neuropsychological characteristics on Sluggish Cognitive Tempo Dimension**

Some studies have confirmed differences in neuropsychological profiles of ADHD subtypes although there is controversy in the results obtained<sup>(2)</sup>. Some have determined a specific deficit in the executive function<sup>(50)</sup>. Currently, the association between TLC and neuropsychological functions still remain under studied<sup>(51)</sup>. Hinshaw et al.<sup>(51)</sup> state that girls with ADHD and high levels of SCT have a low speed in two motor neuropsychological tasks. Some authors have reported academic hindrances –in general– in children and adults with SCT<sup>(52–54)</sup>. Bauermeister et al.<sup>(25)</sup> do not objectify links between SCT and processing speed. These findings are not consistent with the hypothesis that children with SCT have a lower motor/processing speed<sup>(24)</sup>. We may infer that in most studies subjects with ADHD have a worse executive function than subjects with SCT symptoms; and these are usually featured by difficulties regarding: sustained attention<sup>(55)</sup> selective attention<sup>(56)</sup>, variability in spatial memory<sup>(19)</sup>, arousal difficulties<sup>(57)</sup>, in their working memory<sup>(23)</sup>, when decoding information from social signals<sup>58</sup>, in lower motor/ processing speed<sup>(24)(51)(56)</sup>, in mathematical skills, organization difficulties and problems resolution<sup>(59)</sup>. Huang–Pollock et al.<sup>(56)</sup> state that children with ADHD and with high levels of SCT had dysfunctional early selective attention, typical of ADHD. Regarding sustained attention, authors do not agree, as some report worse sustained attention in children ADHD with high levels of SCT; others report that ADHD with high levels of SCT have fewer problems in sustained attention<sup>(59)</sup>.

However, other investigations suggest that SCT is not a executive function disorder, just as experienced in every day activities, and in most questionnaires on executive function appraised during these studies<sup>(60)</sup>. These findings could support the idea that SCT involves alteration of some type of attention, which is not the same attention altered in ADHD. Regarding working memory in community samples of SCT<sup>(61)</sup> it was reported that this could be a factor to be taken into account when evaluating children. Some spatial memory–related reports state higher variability in those subjects with higher levels of SCT<sup>(19)</sup>. This situation does not happen neither

with reaction time nor with the verbal memory.

On its part Wahlstedt & Bohlin<sup>(55)</sup> report that inattention described in DSM–IV was exclusively related with inhibitory control and working memory, but this situation is not replicable for the SCT. Regarding processing speed (PS), there are some contradictory studies, as well; some of them report a deficit in PS in children with high SCT<sup>(16)(21)(24)</sup>, while others do not appreciate such correlation<sup>25</sup>. These contradictions may arise because of the use of various measuring instruments, lack of control of the variables in some of the studies, or maybe because the samples were made with children suffering ADHD, which could influence on results.

### **Impact of the Sluggish Cognitive Tempo dimension in children's life**

TLC dimension, regardless if it is a disorder or not, impacts on various areas of children's lives; however, results are just a few, varied and sometimes contradictory. Research reveals that SCT is mainly associated with social problems<sup>(14)(15)(18)</sup> even after controlling overlapping with ADHD. The nature of social problems related with SCT, according to Mikami et al.<sup>(58)</sup> differs from those manifested in ADHD (aggressiveness, emotional disturbance, disruptive conduct). These are more related with the presence of social withdrawal and isolation<sup>(62)</sup>. These results are consistent with other previous studies, after controlling demographic factors and comorbidity. Among these and other reasons, for which SCT is associated with social withdrawal, and social anxiety, whether if it was studied independent from ADHD, or within the groups with this disorder. However, it is necessary to find the cause of this relationship. Some hypothesis state that maybe SCT symptom of daydreaming leads to social difficulties which may increase anxiety or depressive symptomatology.

Another option could be that people having high levels of SCT are more keen to show anxiety/depression symptoms, linked in turn to social problems. OR may be the cause is totally opposite: more symptoms of anxiety/depression cause social withdrawal or SCT symptomatology. This last hypothesis is not quite possible, as while it is true that SCT is related with anxiety and depression, correlations are moderate and

**Table 1.** Some investigations performed in Sluggish Cognitive Tempo and attention deficit disorder with hyperactivity during the last few years.

| Sample (n) | SCT scale   | Conclusions   | Reference |
|------------|---|---|-----------|
| 282        | SCT scale –5 items (TRF, teachers CBCL parents)     | High correlation SCT–inattention.                                       | 26        |
| 116        | Inclusion of 3 SCT Items in DSM criteria of ADHD    | SCT more prevalent in patients AD-HD–I.                                 | 58        |
| 691        | SCT scale –15 items                                 | SCT symptoms respond likewise than inattention symptoms of DSM.         | 82        |
| 168        | ECRS (Waldman, 1998) 3 items                        | ADHD–I ADHD–C cannot be distinguished due to severity of SCT symptoms . | 83        |
| 163        | DOF (McConaughy Achenbach, 2009) includes SCT scale | SCT is positively associated with AD-HD–I.                              | 32        |
| 322        | CBCL parents (4 SCT Items) TRF teachers (5 items)   | High Association between SCT AD-HD–I.                                   | 16        |
| 141        | SCT–17  | High Correlations in Inattention. Correlation SCT group ADHD.           | 19        |
| 1249       | SCT Scale en adults (9 items)                       | SCT seems to be a factor separated from H/I and inattention.            | 13        |
| 139        | TRF (4 items) CBCL (mothers) (5 items)              | Intercorrelations I H.<br>Intercorrelation I–SCT.                       | 25        |
| 87         | CBCL (4 items)                                      | High levels of SCT associated to AD-HD–I: separated clinical entity.    | 33        |

CBCL = Child Behavior Checklist; DSM = Diagnostic and Statistical Manual for Mental Disorders; DOF = Direct Observation form; ECRS = Emory Combined Rating Scale; SCT = Sluggish Cognitive Tempo; H/ I = Hyperactivity/Impulsivity; I = Inattention; H = Hyperactivity; SCT = Sluggish Cognitive Tempo; ADHD–I = Disorder due to Attention Deficit with Hyperactivity subtype Inattentive; ADHD–C = Disorder due to Attention Deficit With Hyperactivity Subtype Combined; SCT = Sluggish Cognitive Tempo; TRF = Teacher Report Form

share only a minimum variance<sup>(14)(15)(18)</sup>.

Saxbe & Barkley<sup>(22)</sup> reported that few children with SCT had had previous diagnosis of depression, despite this percentage was significantly high compared with ADHD groups and with the control group. Likewise some previous investigations match<sup>(26)(27)</sup>, where SCT is more linked with depression rather than with anxiety, by controlling parents' anxiety and depressive symptoms<sup>20</sup>. Another one of the remarkable aspects when studying SCT, is focused on academic difficulties, although there is some controversy among authors, as many times no direct reports are available (from parents and teachers), or else because most students with SCT go unnoticed in their class. However, more academic difficulties have been reported on people with high levels of SCT<sup>(52)(53)(54)</sup>; however, there are other studies not supporting such relationship<sup>(35)</sup>. This controversy may arise, because many studies take into account SCT symptomatology in groups of children with ADHD, segregated according to high/low scores in such construct<sup>(63)</sup>.

### **Sluggish Cognitive Tempo and its relationship with academic performance in children**

The relationship between SCT and academic performance has caused high interest and many discussions. Langberg et al.<sup>(73)</sup> studied the association between SCT and academic performance in 52 adolescents with ADHD and reported different results. The authors proved the Slowness SCT Subscale, according to parents predicts disruptions in academic performance, i.e. deficit in organization skills and problems to perform duties, beyond ADH symptoms and other characteristics associated with the academic world. By contrast, the Sub-scale Low initiative/Persistence of SCT, according to the teachers, predicted difficulties when performing duties and it was the only SCT variable that predicted medium school marks beyond ADH symptoms and other covariables. These results have not been fully guaranteed, as McBurnett et al.<sup>(61)</sup> did not find a relationship between the Low-initiative Factor and academic performance.

However, total score in SCT and its Drowsy/Tired Factor are inversely associated with academic performance, even after controlling in-

fluence of ADHD. On its part, Becker et al.<sup>(20)</sup> analyzed the relationship of SCT with academic performance difficulties in a sample of 72 college students with ADHD diagnosis evaluated with the Barkley's BAARS-IV Scale made up of four factors: SCT, IN, HI and Impulsivity. Controlling the effect of the other factors, SCT was relevantly correlated with academic performance problems (apart from measures of anxiety and depression). From a more clinical point of view, Marshall et al.<sup>(34)</sup> identified three groups of young subjects diagnosed with ADHD: ADHD-C, ADHD-IN with high SCT and ADHD-IN with low SCT and analyzed their differences regarding academic performance. SCT levels were measured with the three items used in the DSM-IV trials. The results proved that both groups with ADHD-IN had more difficulties in performance in the classroom, compared with the group ADHD-C. Even more, the group ADHD-IN with high SCT was the only one that had problems when performing duties, even when disorders of disruptive behavior were absent.

According to Barkley<sup>(74-76)</sup>, low academic performance and school failure are common among hyperactive children and are one of parents' most frequent concerns. Academic performance usually is a consequence of impulsivity, attention problems, other associated psychopathological components, quality of environmental reinforcements and the capacity to develop relieving gears.

It is likely enough that, due to attentional/memory/executive control difficulties, children have a poor school performance, with low marks, and a higher percentage of cases requiring to receive special education support. Numerous investigations have inquired about the relationship between infant executive function and academic performance of the latter in mathematics<sup>(77-79)</sup>, reading, and problems solving<sup>(80)</sup>. Currently there is some agreement among various authors, regarding a relationship between executive performance and academic performance. For instance, Geary et al.<sup>(81)</sup> performed a study aimed to evaluate the relationship between children's performance in mathematics tests and their performance in tasks related with working memory and processing speed. Geary et al.<sup>(81)</sup> reported that children with a normal perfor-

mance were faster and more accurate when performing tasks related with identifying numeric arrays, recovery and retention of numeric information, lineal estimation and counting capacity.

Understanding that SCT could be a pure attention disorder, we should wonder what role parents, teachers and all education agents have in detecting and early intervening such symptoms, or else, how schools could be prepared to offer timely and personalized responses before each demand. A study made by Barkley<sup>(14)</sup> reports that SCT predicts academic problems and concretely contributes to the problems on written language, reading, organization skills and execution of school tasks. This same pattern is evident in other recent studies with school children<sup>60, 62</sup> alluding difficulties in mathematical performance, and become more evident in SCT rather than in ADHD<sup>(60)(62)</sup>

## DISCUSSION

One of the difficulties involved in SCT is the lack of questionnaires and measuring instruments useful and specific of the construct, and also the lack of coherence when choosing the items in the various studies. In this line, Penny et al.<sup>(18)</sup> developed an SCT scale for parents and teachers, first identifying 26 behaviors associated to SCT construct. Later, with the help of clinical experts they identified the most representative behaviors, and the Scale was reduced to 14 items. After the screening, high correlations between SCT and ADHD-IN were found, lower correlations with ADHD hyperactive/impulsive subtype (ADHD-HI), Oppositional Defiant Disorder (ODD). When controlling the influence between SCT and TDHA-IN, high levels of SCT were found to be associated with low levels of ADHD-HI and TND.

Barkley<sup>(14)</sup> performed a study with 1,922 children adolescents, and proved that SCT and ADHD are different symptomatological dimensions, therefore defining different disorders and highly related, thus proving good validity of the construct. Table # 2 shows some studies on reliability and validity of Sluggish Cognitive Tempo in samples with children and adolescents. Despite significant progress, we still do not know what factors make up SCT, or if these factors are universal. That is to say, just as it ha-

ppens with factors, such as ADHD inattention and hyperactivity/impulsivity, SCT factors may appear in school population of various countries and cultures. Pfiffner et al.<sup>(82)</sup> developed a behavior strategies program for parents and teachers, focused on symptoms and academic problems of children with high SCT symptomatology. Successful results are an example to keep studying potential specific therapies for SCT.

From a psychological point of view, assuming that SCT may be different from ADHD, we cannot assume that behavioral/cognitive therapy or training on social skills are effective for SCT. However, in the light of the close relationship of SCT with internalized disorders, could be expectable that behavioral/cognitive therapy or training on social skills works for handling social/cognitive problems of SCT.

Despite the efforts to improve understanding, evaluation, and diagnosis treatment of ADHD, still there are some pending issues, and one of the biggest dilemmas are probably diagnostic and evaluation. We still do not have objective tests valid enough for such purposes, appealing to a diagnostic structure based on two factors representing ADHD dimension: inattentive behavior and hyperactivity/impulsivity conducts. The problem lies when considering a possible attention disorder, separated from Combined ADHD. The presence or absence of hyperactivity/impulsivity conducts is a key aspect. Despite inattention criteria are the same for Combined ADHD than for Inattentive ADHD, currently many studies support the possible existence of a disorder, or at least of a pure attentional dysfunction. The debate about the existence of a pure attentional dysfunction has generated opposed approaches: on the one hand are those who believe that inattentive behavior in ADHD may be a different disorder; on the other hand, are those who state that if there is an attention disorder or pure concentration disorder, probably it is made up of various conducts, that even if they are related with ADHD inattention, they may represent an independent dimension.

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**Table 2.** Reliability/validity of the Sluggish Cognitive Tempo en samples of children adolescents.

| Sample (n) | SCT scale  | Conclusions  | Reference |
|------------|--|--|-----------|
| 335        | 26 SCT items included in a survey of experts (for parents and teachers). | SCT proper internal validity of strong reliability construct.  | 18        |
| 228        | ECRS (Waldman, 1998) 3 items   | SCT has a limited usefulness.  | 83        |
| 141        | SCT-17   | Alfa Cronbach 0.93 (mothers)   | 19        |
| 365        | SCT scale -10  | Proper convergent validity (8 of 10 items charge in SCT) factor.<br>Proper discriminating validity.  | 31        |
| 802        | CADBI (includes an 8-item SCT Scale)                                     | Proper reliability and validity in Spanish population.   | 85        |
| 711        | 9-item SCT Scale (parents teachers)                                      | Proper internal/external validity.   | 30        |
| 131        | CADBI (includes an 8-item SCT Scale)                                     | 2 factors of inconsistent alert ( $\alpha = 0.86$ )<br>Slowness in Spanish population ( $\alpha = 0.70$ ).                                       | 85        |
| 124        | CCI  | Alfa Cronbach 0.85. Proper external validity. Better SCT considered unidimensional.  | 86        |
| 652        | CADBI (includes an 8-item SCT Scale)                                     | Proper external/convergent validity of SCT symptoms in Chilean population.   | 35        |
| 1045       | CADBI (includes an 8-item SCT Scale)                                     | Proper reliability/validity in Spanish population.   | 87        |
| 1045       | CADBI (includes an 8-item SCT Scale)                                     | Proper external validity in Spanish population.  | 30        |
| 585        | CADBI (includes an 8-item SCT Scale)                                     | Proper external validity in Spanish population. SCT the school is related with internalizing symptoms, at home it is related with deterioration. | 88        |
| 2868       | CADBI (includes a 9-item SCT Scale)                                      | Proper internal/external validity of SCT symptoms in Asian population.   | 89        |
| 325        | SCT-CBCL parents (4 items)   | SCT is related, but it is not redundant, with sleep problems.  | 90        |

CADBI = Child And Adolescent Disruptive Behavior Inventory; CBCL = Child Behavior Checklist; CCI = The Child Concentration Inventory; ECRS = Emory Combined Rating Scale; PC = Population Clinical; PG = Population General; SCT = Sluggish Cognitive Tempo; LD = Learning Disorder; SCT= Sluggish Cognitive Tempo; TRF = Teacher Report Form

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