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Cognitive Functions in Compulsive Buying-Shopping Disorder: a Systematic Review

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Abstract

Purpose of the Review To provide a systematic review of experimental studies concerning cognitive functions in compulsive buying-shopping disorder (CBSD) and to evaluate the studies as supporting or not supporting the affective and cognitive interactions proposed by the Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors.

Recent Findings The results of the present review concerning CBSD mirror findings regarding cue reactivity and disadvantageous decision making in other addictive behaviors, but they also demonstrate a relative lack of experimental studies addressing other cognitive domains such as attentional bias, inhibitory control, implicit associations, or Pavlovian-to-instrumental transfer. Experimental work on physiological and neural correlates of affective and cognitive mechanisms and their interaction in CBSD is still at the beginning.

Summary While a reasonable number of experimental neuropsychological studies support the application of the I-PACE framework to CBSD, future research is required to systematically examine affective and cognitive interactions in CBSD.

Keywords Compulsive buying-shopping disorder · Cognition · Behavioral addiction · Experimental paradigm · I-PACE model

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Introduction

Key features of compulsive buying-shopping disorder (CBSD) include diminished control over the consumption of consumer goods and extreme preoccupation with buying/shopping, resulting in excessive purchasing of items without utilizing them for their intended purposes [1•]. While unregulated buying/shopping behavior leads to substantial negative consequences and impairments in important areas of functioning (e.g., debts, family discord, reduced quality of life) and/or clinically relevant distress, it is continued or even escalated [2]. CBSD is a cross-national public health problem [3•, 4] with an estimated prevalence of approximately 5% in the adult population [5]. However, whether CBSD can be recognized as a distinct mental disorder, and if so, how it should be best classified, has been debated for many years. Because of shared clinical features with impulse control disorders, the categorization of CBSD as such has been favored by some authors in the past [6]. Typical overlapping features are, e.g., repetitive failures to resist a strong impulse or urge to purchase consumer goods, longer-term harm either to the individual or to others due to inappropriate spending, and the increasing tension or affective arousal prior to a CBSD episode, which is relieved while buying/shopping [2]. These considerations may have contributed to the mention of CBSD as an example of "other specified impulse control disorder" in the coding tool of the 11th revision of the International Classification of Diseases (ICD-11) [7]. To be consistent with the ICD-11 terminology, we use the term "compulsive buying-shopping disorder" throughout the text to describe the phenomenon.

Very recently, CBSD has been linked to disorders due to addictive behaviors because of phenomenological and potential neurocognitive similarities [3•, 8–10]. By applying the ICD-11 criteria for gambling and gaming disorders to CBSD, phenomenological parallels exist with respect to impaired control over the behavior (e.g., onset, frequency, intensity, duration, termination, context), increasing priority given to the behavior to the extent that it takes precedence over other life interests and daily activities, continuation or escalation of the behavior despite negative consequences, and significant distress or impairment in important areas of functioning due to the behavior [7]. In terms of neurocognitive overlaps, an increasing number of experimental studies are being published indicating that CBSD fits in the ICD-11 category "disorders due to addictive behaviors" [3•, 8–10].

Regarding neurocognitive processes, it seems reasonable to apply the Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors to CBSD, particularly the inner circle of affective and cognitive interactions [11•]. In accordance with the I-PACE model, an urge to buy/shop something can be induced by internal (e.g., discomfort, boredom, self-insecurity) and/or external (e.g., advertisements, watching influencer posts, having extra money available) triggers. The repeated experience of positive feelings or relief from negative mood states while buying/shopping may result in an attentional bias related to these triggers, which in turn can reinforce the urge to buy/shop (in later stage of CBSD the craving for buying/shopping) and lead to an increase of buying/shopping activities. These interactions may be moderated by reduced general inhibitory control in the early stages and mediated by stimulus-specific inhibitory control deficits in the later stages of CBSD, finally resulting in more and more habitual maladaptive buying/shopping patterns [11•, 12•]. The affective and cognitive processes are likely to be associated with neuroadaptive changes in frontostriatal circuits over time [11•, 13•]. However, while a number of studies investigated affective and cognitive mechanisms in CBSD using behavioral tasks, neuroimaging studies on neural correlates are so far scarce [14••, 15].

The present systematic review of experimental studies addressing cognitive functions in CBSD represents an update of past narrative reviews [9, 10]. It was based on a systematic literature search and subsequent breakdown of results by cognitive domains. Since the number of studies on this topic was still relatively sparse, the time period for literature search was not restricted. At the same time, special attention was paid to progress made since 2018. Furthermore, we differentiated between studies using standardized behavioral tasks and those using adapted task versions with shopping-related cues. Another goal of the present systematic review was to evaluate the studies as supporting or not supporting the affective and cognitive interactions proposed by the I-PACE model [11•].

Method

The literature search aimed to identify all studies that assessed cognitive functions in relation to CBSD with experimental paradigms until July 2022. A comprehensive search string was created and adopted for Scopus and PubMed (see Table S1 in supplementary material). The complete search strings for both engines can be found in the supplementary Table S1. Studies written in English that conducted experimental research in cognitive domains related to CBSD were included. Studies not meeting these criteria were excluded. The initial search from both websites yielded a total of 377 papers (PubMed: 27 and Scopus: 350). After reading titles and abstracts, duplicates and publications not meeting the inclusion criteria were excluded, resulting in a final number of 26 studies included in the present review (see flow diagram, Figure S1 in supplementary material). After reviewing the full texts of included publications, the study results were divided according to cognitive domains they addressed. It is important to note that one paper can belong to more than one domain, if multiple cognitive domains were investigated within the study.

Results

Cognitive Domains

The experimental results were assigned to the following cognitive domains: working memory/learning abilities, attention/attentional bias, cognitive flexibility/planning, cue reactivity/craving, Pavlovian-to-instrumental transfer (PIT; i.e., the shift from behavior underlying Pavlovian conditioning to behavior rather driven by instrumental conditioning), decision making, inhibitory control, implicit associations, and others (i.e., if the paradigm was developed for the specific study). Table S2 (in the supplementary material) lists an overview of all included studies by cognitive domain. Most studies addressed multiple cognitive processes and applied multiple experimental paradigms accordingly. The most important results are summarized below. Of the 26 studies, a total of eight have been published since 2018. Detailed information about all included studies (i.e., sample description, design, operationalization of CBSD, experimental paradigm, outcome variables, main findings) is shown in Table 1.

Working Memory/Learning Abilities

The number of studies that focused particularly on memory processes in CBSD is comparably small. The advantage of the studies is that they all compared individuals with CBSD with healthy control participants. Two studies used established test batteries to measure general cognitive functioning with neutral cues (without shopping-related cues) [16, 18]. Individuals with CBSD exhibited greater deficits in spatial working memory than control participants in one study [16], but did not differ from control participants in another study on a spatial memory and a verbal learning task [18].

In the study of Kyrios et al. [17], a mood induction followed by a subsequent recognition memory task with shopping-related pictures was used. Surprisingly, a memory-facilitating effect of depressed mood was found in healthy control participants but not in individuals with CBSD [17]. In the second part of the same study, a recognition memory task in which products of high or low preference/rank were paired with functional or emotional words was conducted [17]. Persons with CBSD showed inferior performance when products were paired with functional words and superior performance when preferred products were paired with emotional words.

Attention/Attentional Bias

With regard to general, not shopping-related attention and concentration performance, no difference emerged between individuals with CBSD and control participants on the d2-test [22], Stroop Color Word Test [18, 22, 23], and Letter–Number Sequencing subtest from the Wechsler Adult Intelligence Scale [18] between patients with CBSD and healthy control participants. Jiang et al. [21] used an adopted version of the Stroop task (i.e., modified with online shopping words) to investigate potential attentional bias towards online shopping in a convenience sample. Individuals with high symptom severity of online CBSD showed attentional bias towards online shopping-related stimuli [21].

Studies using the dot-probe paradigm (DPP) with shopping-related compared to neutral pictures did not reveal conclusive results. Vogel et al. [20••] reported a lack of differences in DPP performance between patients with CBSD and healthy individuals. Trotzke et al. [19••] and Jiang et al. [21] administered the DPP with shopping-related pictures in convenience samples and did not find significant correlations between symptoms of CBSD and DPP performance. However, it is worth noting that in the Trotzke et al. [19••] study potential habituation effects were observed due to the administration of different tasks. The authors reported significant positive correlations between the attentional bias score and CBSD symptom severity after controlling for sequence effects (order of task administration) [19••].

Cognitive Flexibility/Planning

A small number of studies addressed cognitive flexibility in individuals with CBSD compared to healthy control participants by using standardized (all not adopted with shopping-related cues) experimental paradigms. Derbyshire et al. [16] administered the Intra-Extra Dimensional Set Shift Task to measure rule learning and behavior flexibility. Black et al. [18] and Trotzke et al. [22] used the Wisconsin Card Sorting Test to assess categorization and cognitive shifting abilities. None of the studies included in this review found any differences between individuals with CBSD and control participants [16, 18, 22].

Cue Reactivity

To measure cue-induced affective or craving responses, shopping-related cues were used in all studies, and different methods were chosen: subjective ratings of affective/craving responses (e.g., valence, arousal, urge to shop, purchase desire), peripheral physiological measure (skin conductance response, SCR), electroencephalogram recording (EEG), and functional brain imaging (fMRI).

In convenience samples, a positive correlation between symptoms of CBSD and subjective affective/craving responses towards shopping-related pictures was found [19••, 24••, 25, 26, 29]. Findings from clinical samples support the results. Patients with CBSD reported stronger subjective craving towards shopping-related cues than control participants [20••, 28] and an increase in subjective craving after the cue-reactivity paradigm [28].

Studies measuring cue reactivity with peripheral physiological measures revealed no correlation between SCR and symptom severity of CBSD in a convenience female sample [29]. In a clinical sample, SCR in response to shopping cues was stronger in patients with CBSD than in control participants [28]. However, there were no significant SCR differences within the CBSD group across shopping-related and neutral pictures, which may have indicated a generally elevated level of arousal in individuals with CBSD compared to healthy control individuals.

Lawrence et al. [27] assessed electroencephalogram cue reactivity in a convenience female sample. They used a combination of a recognition memory task with shopping-related pictures and a cue-reactivity paradigm (with a recall and a rating phase), where participants had to indicate their subjective urge to buy for each picture. Responses to preferred and non-preferred items were set in relation to EEG brain

Table 1 Studies on cognitive functions in compulsive buying-shopping disorder (CBSD)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Working memory/learning abilities						
Derbyshire et al., 2014 (USA) [16]	$n_{CBSD}=23$ 22.3 ± 3.5 years 60.9% f $n_{CG}=23$ 21.1 ± 3.4 years 60.9% f	CBSD[2] vs. CG	Minnesota Impulse Disorders Interview	Spatial working memory task (no shopping-related cues included)	Number of errors, strategic performance	Poorer performance (more errors, inferior strategies) in CBSD than CG
Kyrios et al., 2013 (Australia) [17]	$n_{CBSD}=18$ 38.9 ± 17.7 years 70.6% f $n_{CG}=17$ 37.1 ± 13.7 years 88.9% f	CBSD[2] vs. CG	CBS	Study 1: mood induction and subsequent recognition memory task with shopping-related pictures Study 2: semantic-memory task with shopping-related pictures	Recognition of shopping-related pictures	Study 1: Memory-facilitating effect of depressed mood in CG but not CBSD Study 2: CBSD more strongly associated consumer items with emotional concepts than with concepts of function
Black et al., 2012 (USA) [18]	$n_{CBSD}=26$ 36.3 ± 15.7 years 88.5% f $n_{CG}=32$ 39.4 ± 14.8 years 84.4% f	CBSD[2] vs. CG	CBS, McElroy et al. criteria	1) Brief Visuospatial Memory Test-Revised, 2) Hopkins Verbal Learning Task-Revised	Total and delayed recall	No group differences
Attention/attentional bias						
Trotzke et al., 2020 (Germany) [19••]	$N=277$ 24.6 ± 9.5 years 74.4% f	Convenience sample	PBS	DPP with shopping-related and neutral pictures	Attentional bias score (subtracting mean reaction time of congruent trials from mean reaction time of incongruent trials)	No correlations between DPP performance and symptoms of CBSD in the total sample, but in subsamples when controlling for habituation effects
Vogel et al., 2019 (Germany) [20]	$n_{CBSD}=39$ 45.0 ± 10.8 years 74.4% f $n_{CG}=39$ 44.8 ± 10.6 years 74.4% f	CBSD[1] vs. CG	PBS, McElroy et al. criteria	DPP with shopping-related and neutral pictures	Attentional bias score (subtracting mean reaction time of congruent trials from mean reaction time of incongruent trials)	No group differences
Jiang et al., 2017 (China) [21]	$N=98$ 20.6 ± 1.3 years 54.0% f	Convenience sample 3 symptom severity groups: 1) high, $n=27$, 2) medium, $n=43$, 3) low, $n=28$	Online Shopping Addiction Scale	1) DPP with shopping-related and neutral pictures, 2) Modified Stroop Task with shopping-related words	Mean reaction times	DPP: No group differences Stroop: Attentional bias towards online shopping-related stimuli in group 1

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Trotzke et al., 2015b (Germany) [22]	$n_{CBSD}=30$ 42.8 ± 10.6 years 73.3% f $n_{CG}=30$ 42.0 ± 10.3 years 73.3% f	CBSD[1] vs. CG	CBS, German Addictive Buying Scale, SCID for impulse control disorders	1) d2-test, 2) Stroop Color Word Test (no shopping-related cues included)	1) Total items minus failures, 2) Mean reaction times	No group differences
Voth et al., 2014 (Germany) [23]	$n_{CBSD}=31$ 40.7 ± 11.3 years 80.6% f $n_{CG}=28$ 39.1 ± 10.3 years 82.1% f	CBSD[1] vs. CG	CBS, SCID for impulse control disorders	Stroop Color Word Test (no shopping-related cues included)	Mean reaction times	No group differences
Black et al., 2012 (USA) [18]	$n_{CBSD}=26$ 36.3 ± 15.7 years 88.5% f $n_{CG}=32$ 39.4 ± 14.8 years 84.4% f	CBSD[2] vs. CG	CBS, McElroy et al. criteria	1) Stroop Color Word Test, 2) Letter–Number Sequencing subtest from the Wechsler Adult Intelligence Scale (no shopping-related cues included)	1) Mean reaction times, 2) Letter numbering sequencing	No group differences
Cognitive flexibility/planning						
Trotzke et al., 2015b (Germany) [22]	$n_{CBSD}=30$ 42.8 ± 10.6 years 73.3% f $n_{CG}=30$ 42.0 ± 10.3 years 73.3% f	CBSD[1] vs. CG	CBS, German Addictive Buying Scale, SCID for impulse control disorders	1) Trail-Making Test A and B, 2) Modified Card Sorting Test, 3) Tower of Hanoi (no shopping-related cues included)	1) Completion time, 2) Number of categories reached, number of preservative errors, 3) Number of moves and time needed for completion of Tower of Hanoi	No group differences
Derbyshire et al., 2014 (USA) [16]	$n_{CBSD}=23$ 22.3 ± 3.5 years 60.9% f $n_{CG}=23$ 21.1 ± 3.4 years 60.9% f	CBSD[2] vs. CG	Minnesota Impulse Disorders Interview, McElroy et al. criteria	Intra-Extradimensional Set Shift Task (no shopping-related cues included)	Total number of errors	No group differences
Black et al., 2012 (USA) [18]	$n_{CBSD}=26$ 36.3 ± 15.7 years 88.5% f $n_{CG}=32$ 39.4 ± 14.8 years 84.4% f	CBSD[2] vs. CG	CBS, McElroy et al. criteria	1) Trail-Making Test A and B 2) WCST (no shopping-related cues included)	1) Completion time, 2) total errors, preservative responses, non-preservative errors, preservative errors, categories completed, learning to learn	No group differences

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Cue reactivity/craving						
Trotzke et al., 2021 (Germany) [14••]	$n_{CBSD} = 18$ 47.7 ± 8.6 years 88.9% f $n_{CG} = 18$ 49.7 ± 10.1 years 88.9% f	CBSD[1] vs. CG	PBS, McElroy et al. criteria	CRP with shopping-related and neutral pictures, fMRI	Subjective craving and differences in BOLD signal during CRP	Higher subjective craving towards shopping-related pictures in CBSD than CG During CRP: higher activities in the dorsal striatum in CBSD than CG; no group differences in the ventral striatum; activity in ventral striatum associated with symptom severity in CBSD group
Trotzke et al., 2020 (Germany) [19••]	$N = 277$ 24.6 ± 9.5 years 74.4% f	Convenience sample	PBS	CRP with shopping-related pictures	Subjective craving (valence, arousal, urge to buy)	Positive correlation between subjective craving and symptoms of CBSD
Trotzke et al., 2019 (Germany) [24••]	$N = 57$ 31.4 ± 10.6 years 52.6% f	Convenience sample	Short Internet Addiction Test-shopping	CRP with online shopping-related and neutral pictures	Subjective craving (valence, arousal, urge to buy)	Moderate correlation between subjective craving towards shopping-related pictures and symptoms of online CBSD
Vogel et al., 2019 (Germany) [20••]	$n_{CBSD} = 39$ 45.0 ± 10.8 years 74.4% f $n_{CG} = 39$ 44.8 ± 10.6 years 74.4% f	CBSD[1] vs. CG	PBS, McElroy et al. criteria	CRP with shopping-related pictures	Subjective craving (valence, arousal, urge to buy)	Higher subjective craving towards shopping-related pictures in CBSD than CG
de Vries et al., 2018 (The Netherlands) [25] Study 2	$N = 134$ 19.8 ± 1.9 years 40.3% f	Convenience sample	CBS	Modified CRP: Participants had to choose between a pair of socks and a pair of jeans on sale Note: Participants randomly assigned to 1) close friend condition, 2) acquaintance condition and 3) informed of a positive event	Subjective purchase desire	Positive correlation between subjective purchase desire and symptoms of CBSD. For participants with high symptom severity of CBSD, the presence of a friend *reduced* the purchase desire as compared to a positive event and acquaintance condition

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
de Vries et al., 2018 (The Netherlands) [25] Study 4	$N = 64$ 19.7 ± 3.2 years 48.4% f	Convenience sample	CBS	Same hypothetical situation as in Study 2 Note: Participants randomly assigned to 1) close friend condition and 2) acquaintance condition	Subjective purchase desire	Positive correlation between subjective purchase desire and symptoms of CBSD. For participants with high symptom severity of CBSD, the presence of a friend (as compared to acquaintance) *decreased* the purchase desire, while for individuals without CBSD, it *increased* the purchase desire
Trotzke et al., 2015a (Germany) [26]	$N = 240$ 26.6 ± 10.4 years 100% f	Convenience sample	Short Internet Addiction Test-shopping	CRP with online shopping-related pictures cues	Subjective craving (arousal, urge to buy)	Positive correlation between subjective craving and symptoms of online CBSD pre and post CRP; increase in subjective craving after the CRP in participants with high symptom severity of online CBSD
Lawrence et al., 2014 (Australia) [27]	$N = 22$ 25.3 ± 7.2 years 100% f	Convenience sample	CBS, Compulsive Acquisition Scale, Buying Cognition Inventory	Modified CRP with recognition memory task and shopping-related pictures	Subjective urge to buy and EEG coherence measures	High subjective craving in participants with high symptom severity of CBSD; left-sided lateralization in the EEG during presentation of high-urge items in relation to CBSD symptom severity
Trotzke et al., 2014 (Germany) [28]	$n_{CBSD} = 30$ 42.8 ± 10.6 years 73.3% f $n_{CG} = 30$ 42.0 ± 10.3 years 73.3% f	CBSD[1] vs. CG	CBS, German Addictive Buying Scale, McElroy et al. criteria	CRP with shopping-related and neutral pictures	Subjective craving (valence, arousal, urge to buy), skin conductance response	Higher subjective craving and higher skin conductance response towards shopping-related pictures in CBSD than CG; increase in subjective craving after the CRP in CBSD

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Starcke et al., 2013 (Germany) [29]	$N = 66$ 22.9 ± 4.3 years 100% f	Convenience sample	CBS	CRP with shopping-related cues	Subjective craving (valence, arousal, urge to buy), skin conductance response	Positive correlation between subjective craving and symptoms of CBSD; skin conductance response not related to CBSD symptom severity
Raab et al., 2011 (Germany) [15]	$n_{CBSD} = 23$ 42.2 ± 12.2 years 100% f $n_{CG} = 23$ 41.7 ± 10.8 years 100% f	CBSD[1] vs. CG	German Addictive Buying Scale	Adapted Saving Holdings or Purchase Task with pictures of consumer products, fMRI	Differences in BOLD activities during decision task	Higher activity in striatum for subsequently bought products in CBSD than CG during product presentation; lower activity in insula in CBSD than CG during price presentation; higher activity in anterior cingulate cortex during purchase decisions in CBSD than CG
Pavlovian-to-instrumental transfer						
Vogel et al., 2018 (Germany) [30••]	$N = 66$ 23.8 ± 3.1 years 65.2% f	Convenience sample	Short Internet Addiction Test-shopping	PIT-paradigm with pictures related to online gaming and online shopping 1) Pavlovian phase, 2) Instrumental phase, 3) Transfer phase	Feasibility of PIT-paradigm in gaming/CBSD, awareness of contingencies, gaming/shopping, PIT-effect	Feasibility established; gaming and shopping PIT-effect in persons who learned contingencies during Pavlovian trainings phase; magnitude of shopping PIT-effect not associated with symptoms of online CBSD
Decision making—standardized tasks						
Trotzke et al., 2019 (Germany) [24••]	$N = 57$ 31.4 ± 10.6 years 52.6% f	Convenience sample	Short Internet Addiction Test-shopping	IGT modified with online shopping-related and control pictures	IGT net score	More disadvantageous decisions when online shopping pictures were displayed on the disadvantageous decks compared to when online shopping pictures were displayed on the advantageous decks

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Nicolai et al., 2017 (Germany) [31]	N = 103 28.2 ± 9.4 years 69.9% f	Convenience sample	PBS	Delay Discounting Task with loan variant (no shopping-related cues included)	Area under the curve (the degree to which the participant delayed the reward)	CBSD symptoms negatively predicted area under the curve, indicating that more symptoms of CBSD are associated with more delay discounting
Trotzke et al., 2015b (Germany) [22]	$n_{CBSD} = 30$ 42.8 ± 10.6 years 73.3% f $n_{CG} = 30$ 42.0 ± 10.3 years 73.3% f	CBSD[1] vs. CG	CBS, German Addictive Buying Scale, SCID for impulse control disorders	IGT, GDT (no shopping-related cues included)	IGT net score; GDT net score, frequency of risky options chosen	IGT: more disadvantageous decisions in CBSD than CG GDT: no group differences
Vogt et al., 2015 (Germany) [32]	$n_{CBSD} = 28$ 31.2 ± 10.0 years 78.6% f $n_{CG} = 21$ 33.1 ± 12.3 years 81.0% f	CBSD[2] vs. CG	German Addictive Buying Scale, CBS	GDT (no shopping-related cues included)	Frequency of risky options chosen, total bank balance	No group differences
Voth et al., 2014 (Germany) [23]	$n_{CBSD} = 31$ 40.7 ± 11.3 years 80.6% f $n_{CG} = 28$ 39.1 ± 10.3 years 82.1% f	CBSD[1] vs. CG	CBS, SCID for impulse control disorders	IGT (no shopping-related cues included)	IGT net score	More disadvantageous decisions in CBSD than CG
Black et al., 2012 (USA) [18]	$n_{CBSD} = 26$ 36.3 ± 15.7 years 88.5% f $n_{CG} = 32$ 39.4 ± 14.8 years 84.4% f	CBSD[2] vs. CG	CBS, McElroy et al. criteria	IGT (no shopping-related cues included)	IGT net score	No group differences
Billieux et al., 2010 (Switzerland) [33]	N = 95 23.3 ± 2.1 years 50.5% f	Convenience sample	French Questionnaire about Buying Behavior	IGT (no shopping-related cues included)	IGT net score, difference between first and last 40 trials	No correlation between IGT performance and symptoms of CBSD
Derbyshire et al., 2014 (USA) [16]	$n_{CBSD} = 23$ 22.3 ± 3.5 years 60.9% f $n_{CG} = 23$ 21.1 ± 3.4 years 60.9% f	CBSD[2] vs. CG	Minnesota Impulse Disorders Interview, McElroy et al. criteria	Cambridge Gambling Task (no shopping-related cues included)	Proportion of rational decisions and points gambled; risk adjustment	Poorer decision making and less risk adjustment in CBSD than CG

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Decision making—buying-shopping specific tasks						
Vogt et al., 2014 (Germany) [34]	$n_{CBSD}=40$ 23.0 ± 23.5 years 100% f $n_{CG}=40$ 23.2 ± 23.1 years 100% f	CBSD vs. CG	German Addictive Buying Scale, CBS	Mood induction with subsequent purchase task with pictures of consumer products	Shopping-related proxies: willingness to pay more money, product-specific urge to buy, probability to buy	Participants with high compared to those with low CBSD symptom severity exhibited higher extent of shopping-related proxies; no effect of mood induction on shopping-related proxies
McQueen et al., 2014 (Australia) [35]	$n_{CBSD}=17$ 38.9 ± 15.7 years $n_{CG}=18$ 37.1 ± 13.7 years Total: 80% f	CBSD[2] vs. CG	CBS, Buying Cognition Inventory	Purchase task with pictures of tempting and neutral consumer products, either minimizing or maximizing buying beliefs and financial constraints conditions	Decision to buy	Participants with high compared to those with low CBSD symptom severity showed less inhibition of urges to buy non-essential items due to financial constraints and if buying-related beliefs were maximized
Raab et al., 2011 (Germany) [15]	$n_{CBSD}=23$ 42.2 ± 12.2 years 100% f $n_{CG}=23$ 41.7 ± 10.8 years 100% f	CBSD[1] vs. CG	German Addictive Buying Scale	Adapted Saving Holdings or Purchase Task with pictures of consumer products, fMRI	Differences in BOLD activities during decision task	Higher activity in striatum for subsequently bought products in CBSD than CG during product presentation; lower activity in insula in CBSD than CG during price presentation; higher activity in anterior cingulate cortex during purchase decisions in CBSD than CG
Inhibitory control						
Trotzke et al., 2020 (Germany) [19••]	$N=277$ 24.6 ± 9.5 years 74.4% f	Convenience sample	PBS	Affective Shifting Task with shopping-related and neutral pictures	Number of commission errors	No correlation between commission errors and symptoms of CBSD, but interactions of inhibitory control, implicit cognitions, and craving towards symptoms of CBSD

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Lindheimer et al., 2020 (Germany) [36••]	$N=222$ 27.1 ± 8.4 years 67.5% f	Convenience sample	PBS	Stroop Matching Task (no shopping-related cues included)	Reaction time in interference condition	Positive correlation between stimulus interference and symptoms of CBSD
Vogel et al., 2019 (Germany) [20••]	$n_{CBSD}=39$ 45.0 ± 10.8 years 74.4% f $n_{CG}=39$ 44.8 ± 10.6 years 74.4% f	CBSD[1] vs. CG	PBS, McElroy et al. criteria	Go/ No-Go with shopping-related and neutral pictures	Number of commission errors	No group differences
de Vries et al., 2018 (Netherland) [25] Study 1	$N=67$ 19.8 ± 1.7 years 100% f	Convenience sample	CBS	Modified Go/No-Go Task with clothing (= tempting) versus basic furniture pictures, participants assigned randomly to 1) friendship reminder condition or 2) control condition	Total number of failures to inhibit responses to No-go (clothing) items	In participants with high symptom severity of CBSD, the 'Friendship reminder' condition was associated with lower number of inhibition failures compared to the control condition
de Vries et al., 2018 (Netherland) [25] Study 3	$N=130$ 19.4 ± 1.7 years 100% f	Convenience sample	CBS	Color Word Stroop Task (no shopping-related cues included), participants had to bring a close friend. Participants assigned randomly to 1) being alone 2) staying with their friend 3) being with a stranger condition	Average response latencies on incongruent trials	In participants with high symptom severity of CBSD, the physical presence of a friend was associated with decreased response latencies as compared to being alone or with a stranger
de Vries et al., 2018 (Netherland) [25] Study 5	$N=40$ 20.4 ± 1.8 years 100% f	Convenience sample	CBS	Go/NoGo-Task with clothing (tempting) versus basic furniture pictures, fMRI; participants assigned randomly to 1) Friendship reminder condition or 2) control condition	Total number of failures to inhibit responses to No-go (clothing) items, differences in BOLD activities	In participants with high compared to those with low symptom severity of CBSD: less inhibition failures and higher activity in ACC and dlPFC in No-go trials in friendship reminder condition
Nicolai et al., 2016 (Germany) [37]	$N=100$ 27.8 ± 12.2 years 70% f	Convenience sample	PBS	Go/No-Go Task (no shopping-related cues included)	Number of commission errors	Positive correlation between commission errors and symptoms of CBSD

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Hague et al., 2016 (UK) [38]	$n_{CBSD}=52$ 25.0 ± 7.9 years 55% f $n_{CG}=51$ 28.4 ± 1.5 years 48% f	CBSD² vs. CG	CBS	Go/No-Go Task with shopping-related and neutral pictures and arousal induction	Number of commission errors	Generally poor task performance in CBSD compared to CG, regardless of task condition
Vogt et al., 2015 (Germany) [32]	$n_{CBSD}=28$ 31.2 ± 10.0 years 78.6% f $n_{CG}=21$ 33.1 ± 12.3 years 81.0% f	CBSD² vs. CG	German Addictive Buying Scale, CBS	Stop Signal Task (no shopping-related cues included)	Stop signal reaction time	No group differences
Derbyshire et al., 2014 (USA) [16]	$n_{CBSD}=23$ 22.3 ± 3.5 years 60.9% f $n_{CG}=23$ 21.1 ± 3.4 years 60.9% f	CBSD² vs. CG	Minnesota Impulse Disorders Interview	Stop Signal Task (no shopping-related cues included)	Stop signal reaction time	Poorer task performance in CBSD than CG
Billieux et al., 2010 (Switzerland) [33]	$N=95$ 23.3 ± 2.1 years 50.5% f	Convenience sample	French questionnaire about buying behavior	Emotional Stop Signal Task with 3 types of human emotional expressions	Stop signal reaction time	No correlation between task performance and symptoms of CBSD
Implicit associations						
Trotzke et al., 2020 (Germany) [19••]	$N=277$ 24.6 ± 9.5 years 74.4% f	Convenience sample	PBS	IAT with shopping-related and neutral pictures	D_{2SD} Score	No correlation between D_{2SD} score and symptom severity of CBSD in the total sample, but in subsamples when controlling for habituation effects
Vogel. et al., 2019 (Germany) [20••]	$n_{CBSD}=39$ 45.0 ± 10.8 years 74.4% f $n_{CG}=39$ 44.8 ± 10.6 years 74.4% f	CBSD¹ vs. CG	PBS, McElroy et al. criteria	IAT with shopping-related and neutral pictures	D_{2SD} Score	No group difference

Table 1 (continued)

Study (country)	Sample N/n Age (mean ± SD) % females	Design	Operationalization of CBSD	Paradigm	Outcome variable	Main findings
Black et al., 2012 (USA) [18]	$n_{CBSD}=26$ 36.3 ± 15.7 years 88.5% f $n_{CG}=32$ 39.4 ± 14.8 years 84.4% f	$CBSD^2$ vs. CG	CBS, McElroy et al. criteria	Controlled Oral Word Association Test (no shopping-related cues included)	Number of produced words	No group difference
Other						
Nicolai et al., 2018 (Germany) [39]	N = 78 23.5 ± 5.2 years 76.92% f	Convenience sample	PBS	Time production task	Accuracy of time prediction	Negative correlation between symptoms of CBSD and accuracy of time prediction
Black et al., 2012 (USA) [18]	$n_{CBSD}=26$ 36.3 ± 15.7 years 88.5% f $n_{CG}=32$ 39.4 ± 14.8 years 84.4% f	$CBSD^2$ vs. CG	CBS, McElroy et al. criteria	WASI; Picture completion subtest; BDAE animal naming test (no shopping-related cues included)	Full IQ scale; ability to perceive visual details quickly; verbal fluency	No group differences for WASI and BDAE; CBSD group scored significantly higher on the picture completion task

ACC, anterior cingulate cortex; *BDAE*, Boston Diagnostic Aphasia Examination; *BOLD*, blood oxygen level dependent; *CBSD[1]*, treatment-seeking patients; *CBSD[2]*, individuals with high CBSD scores on questionnaires; *CBS*, compulsive buying screener; *CG*, control group; *CRP*, cue-reactivity paradigm; *dlPFC*, dorsolateral prefrontal cortex; *DPP*, dot-probe paradigm; *fMRI*, functional magnetic resonance imaging; *GDT*, Game of Dice Task; *IAT*, Implicit Association Task; *IGT*, Iowa Gambling Task; *IQ*, intelligence quotient; *PBS*, Pathological Buying Screener; *PIT*, Pavlovian-to-instrumental transfer; *SCID*, structured clinical interview for DSM; *WASI*, Wechsler Abbreviated Scale of Intelligence; *WCST*, Wisconsin Card Sorting Test connectivity. The results indicated a left-sided lateralization in the EEG during the presentation of high-urge items in relation to CBSD symptom severity [27].

Trotzke et al. [14••] investigated neural correlates of cue reactivity in patients with CBSD compared to healthy control participants. They applied a cue-reactivity paradigm with individualized shopping-related and control pictures using fMRI and found stronger activities in the dorsal (but not in the ventral) striatum in patients with CBSD than in control participants during exposure to shopping-related compared to neutral pictures. However, increased activity in the ventral striatum was related to symptom severity in individuals with CBSD but not in the control group [14••]. These correlational results were consistent with the fMRI findings of Raab et al. [15] who found increased activity in the ventral striatum (nucleus accumbens) when patients with CBSD were presented with images of attractive consumer goods.

Pavlovian-to-Instrumental Transfer

The shift from Pavlovian-to-instrumental conditioning has been studied in many mental health conditions including substance use disorders and behavioral addictions (for an overview: Garbusow et al., 2022 [40]), but only once so in CBSD. Vogel et al. [30••] administered a PIT paradigm with appetitive pictures related to online gaming and online shopping applications in a convenience sample. During the Pavlovian phase, 62% of the sample learned the experimental contingencies and were able to discriminate between stimuli predicting the presentation of gaming-related pictures and stimuli predicting the presentation of shopping-related pictures. Symptoms of gaming disorder, but not online CBSD, predicted awareness [30••]. Specific PIT-effects for gaming and buying/shopping were observed in persons aware of experimental contingencies [30••]. Symptom severity of gaming disorder contributed to the gaming PIT-effect, while the magnitude of buying/shopping PIT-effect was not associated with online CBSD symptom severity [30••].

Decision Making

To explore decision-making abilities in CBSD, mainly standardized versions (without shopping-related cues) of the Iowa Gambling Task (IGT), Cambridge Gambling Task (CGT), Delay Discounting Task (DDT), and Game of Dice Task (GDT) have been utilized. Studies using the IGT, which assesses decision making under ambiguity, revealed mixed results. Billieux et al. [33] found no correlation between IGT net scores and symptoms of CBSD in a convenience sample and Black et al. [18] found no differences between individuals with CBSD and controls in IGT performance. In contrast, the studies of Trotzke et al. [22] and Voth et al. [23] indicated more disadvantageous decision making under ambiguity in patients with CBSD compared to control participants. Studies involving the DDT in a convenience sample [31] or the CGT in a clinical sample [16] also showed decision-making deficits related to CBSD. In terms of decision making under risky conditions, however, studies using the GDT did not find group differences between individuals with a high propensity towards CBSD compared to those with low propensity [32] or patients with CBSD compared to control participants [22].

The more recent IGT study by Trotzke et al. [24••] is an exception because it used a modified task with online shopping-related pictures placed either on the advantageous decks or on the disadvantageous decks (with control pictures on the opposing ones in a convenience sample). Participants with high online CBSD symptom severity compared to those with low severity showed performance deficits when the shopping cues were placed on the disadvantageous decks [24••].

The following three studies made use of adapted or specifically developed, closer to “real-world”, buying/shopping-specific decision-making tasks with images of consumer products. Vogt et al. [34] applied a mood induction and subsequent purchase task with pictures of consumer goods of relevance for female shoppers (clothes, shoes, jewelry, makeup). They assessed the following shopping-related proxies: likelihood to expose oneself to shopping websites, willingness to pay more money, product-specific urge to buy, and probability to buy. Participants with high symptom severity of CBSD differed from those with low severity in all variables, except the willingness to pay [34]. McQueen et al. [35] utilized images from eight product categories (body care items, accessories, sports equipment, kitchen items, clothes, jewelry, footwear, electronic leisure items) and found that buying-related cognitions may increase the likelihood to purchase consumer items on a shopping-related decision-making task, regardless of financial constraints. Raab et al. [15] investigated the neural correlates of purchasing decisions with fMRI by using an adapted version of the Saving Holdings or Purchase task [41] with images from six product categories (accessories, drinks, clothing, cosmetics, jewelry, and sweets). They found a higher activity in the ventral striatum (nucleus accumbens) during the presentation of purchasable products, lower insula activity during price presentation, and increased activation of the anterior cingulate cortex (ACC) during purchase decisions in individuals with CBSD compared to control participants [15].

Inhibitory Control

The experimental studies that have employed behavioral tasks to examine response inhibition in CBSD reported mixed findings. With regard to studies using traditional behavioral tasks (without shopping-related cues) in convenience samples, poor response inhibition as measured with the Stroop Matching Task or the Go/No-Go Task was related to more symptoms of CBSD in two studies [36••, 37], while no correlations between task performance and symptoms of CBSD were found regarding the Stop Signal Task in a third study [33]. By using shopping-related versus neutral cues, Hague and colleagues [38] found that individuals with high symptom severity of CBSD performed worse on the Go/No-Go task.

Using the Stop Signal Task in clinical samples, individuals with CBSD did not differ from the control group in one study [32] but showed poorer task performance than control participants in another study [16]. Applying a modified version of the Go/No-Go Task with shopping-related and neutral pictures, no differences in task performance between patients with CBSD and control participants were found in the study of Vogel et al. [20••]. However, using a modified affective shifting task in a convenience sample, Trotzke et al. [19••] indicated interactions between implicit cognitive processes (attentional bias, implicit associations), craving responses, and inhibitory control performance on symptom severity of CBSD [19••].

A unique study (including 5 sub-studies) on the effect of friendship reminders on inhibitory control was carried out by de Vries et al. [25] in a convenience sample. In sub-study 1, participants were assigned to a "friendship reminder condition" or a control condition and performed a modified Go/No-Go Task with tempting clothing pictures compared to basic furniture pictures. The results indicated that remembering a close friend ("friendship condition") was associated with less inhibition failures in No-go trials (clothing items) in participants with high symptom severity of CBSD compared to those with low severity. In sub-study 3, task performance on the incongruent trial of the traditional Stroop Color Word Task (without shopping-related cues) was used to assess participants' ability to identify a conflict and to implement self-control [25] (note that according to the authors, the task was not used to assess attention). Participants had to bring a close friend and were assigned to one of the following conditions: (1) being alone, (2) staying with a friend, or (3) being with a stranger. The mere physical presence of a friend reduced the response latencies on incongruent trials in individuals with high CBSD scores as compared to being alone or with a stranger. Sub-study 5 explored the neural correlates of friendship reminders on inhibitory control (same modified Go/No-Go Task as in sub-study 1). Participants with low levels of CBSD showed reduced activation in the ACC and dorsolateral prefrontal cortex after friendship reminders, while participants with high CBSD symptoms had an increased activity in these brain areas [25]. Taken together, the findings of de Vries et al. [25] suggest that for individuals with CBSD, friendship reminders or the presence of a friend increase self-control in shopping-related conflict situations.

Implicit Associations

At present, there is a relative lack of experimental studies addressing implicit associations in relation to CBSD. Black et al. [18] did not find differences in general associative abilities (verbal fluency) between patients with CBSD and control participants in the Controlled Word Association Test (without shopping-related cues). More recently, a modified version of the Implicit Associations Task (IAT) with shopping-related versus neutral pictures was applied to assess implicit associations towards buying/shopping. By using the same modified IAT in their studies, Vogel et al. [20••] did not observe differences in implicit associations between patients with CBSD and control participants, and Trotzke et al. [19••] did not detect a link between task performance and CBSD symptoms in a convenience sample. However, when the analyses were adjusted for habituation effects (i.e., controlling for order of task administration) in the Trotzke et al. [19••] study, more symptoms of CBSD were associated with more positive implicit associations towards shopping-related cues.

Application of the I-PACE Model to CBSD

Figure 1 attempts to place the studies concerning cognitive functions in CBSD that support or do not support assumptions of the I-PACE model within the inner circle of affective and cognitive interactions [11•]. While research clearly supports the prominent role of cue reactivity and craving, relatively few studies have addressed the other components of the model, or studies have not produced conclusive results. Nevertheless, a reasonable number of experimental neuropsychological studies, particularly those using shopping-specific cues, support the application of the I-PACE framework to CBSD (see Table 1 for details).

Conclusions

The results of the present review concerning CBSD mirror findings regarding cue reactivity, craving, and disadvantageous decision making in other addictive behaviors [9, 10, 11•, 13•, 14••, 15, 16, 19••, 20••, 22, 23, 24••, 26–29, 31, 34, 35, 42–44], but they also demonstrate a relative lack of experimental studies addressing other cognitive domains (e.g., attentional bias, inhibitory control, implicit associations, Pavlovian-to-instrumental transfer). As shown in Fig. 1, there is, however, preliminary support for affective and cognitive mechanisms and their interactions in CBSD as assumed by the I-PACE model for addictive behaviors [11•]. This applies in particular to cue-induced craving [14••, 15, 19••, 20••, 24••, 26–29] and disadvantageous decision making under ambiguity [22, 23, 24••] which may be the basis for shopping-specific habitual decisions and behaviors [15, 24••, 30••, 34, 35]. Other studies stressed the role of buying-related beliefs in CBSD [35]. Some studies showed moderating effects of craving, implicit associations, or inhibitory control on symptoms of CBSD [19••] or on decision making [24••], providing further insights into potential pathomechanisms and support for the application of the I-PACE model to CBSD. Experimental work on the neural correlates of cue reactivity and executive functioning in CBSD is still at the beginning. The few neuroimaging studies highlight the importance of striatal activity in cue exposure and of prefrontal structures, ACC, and insula in inhibitory control/goal conflict identification [14••, 15, 25]. These outcomes together with the other results mentioned above correspond with findings about cue reactivity, craving, executive functions, and neural pathways involved in addictive disorders [8, 11•, 44]. Therefore, the present findings do not only support the application of the theoretical I-PACE framework to CBSD, but they also argue for classifying CBSD as a disorder due to addictive behaviors.

The interest in CBSD in the last years has accelerated, and there has been progress in neurocognitive research on CBSD compared to the last reviews [9, 10]. An advantage of most studies published since 2018 is that, with few exceptions, they have used behavioral tasks with disorder-specific shopping cues. Nevertheless, the number of experimental studies conducted within the past 5 years is low as compared to experimental and neuroimaging studies in other behavioral addictions, e.g., gaming disorder [13•, 45]. Studies of CBSD primarily addressed cue reactivity and possible deficits in inhibitory control processes in CBSD as key characteristics of addictive behaviors. In contrast, attentional processes, implicit associations, and the shift from Pavlovian-to-instrumental conditioning have been studied less intensively.

Clinical Implications

The importance of cue-induced craving responses in CBSD has several clinical implications. Buying and shopping are necessary everyday activities. The complete avoidance of stores and online shopping platforms or abstinence from the consumption of consumer goods is not realistic. The ubiquity of advertising, merchandising, and other external buying/shopping stimuli can cause strong urges to buy/shop

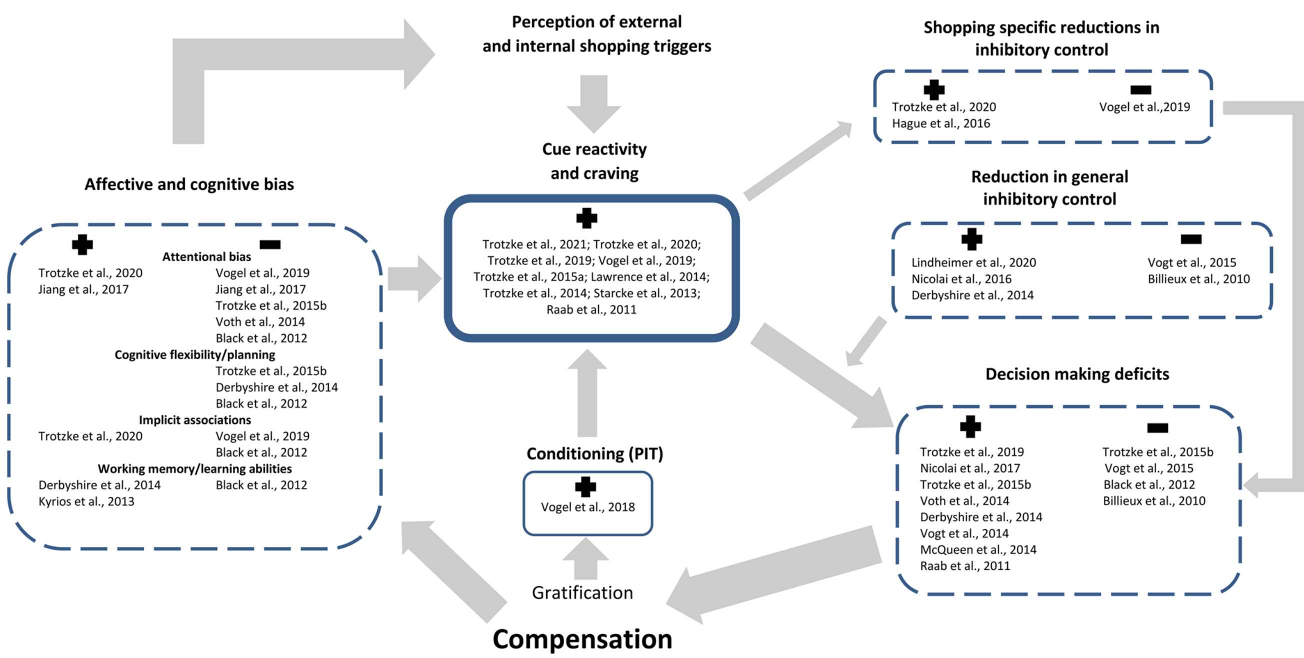

Fig. 1 Experimental studies on cognitive functions in CBSD supporting (+) or not supporting (−) the assumptions of the I-PACE model for addictive behaviors [11•]. Notes: A detailed description of all studies is shown in Table 1. The paper by de Vries and colleagues [25] has not been included in Figure 1 due to the highly specific 'friendship' condition. The paper by Nicolai et al. [39] and components of the investigation by Black et al. [18] have not been included in Figure 1 due to high specificity of tasks. The thickness of the blue boxes in the Figure represents the supporting and non-supporting studies. Figure 1 must be interpreted under consideration of the fact that the included studies differ regarding the methodology (i.e., sample size, convenience vs. clinical sample, neutral cues vs. shopping specific cues etc.). PIT = Pavlovian-to-instrumental transfer

and craving responses. Therefore, psychotherapy of CBSD should deal with external (e.g., advertisements, watching influencer posts, having extra money available) and internal (e.g., discomfort, boredom, self-insecurity) triggers and strengthen self-control abilities to normalize buying/shopping behaviors. Traditional cognitive-behavioral strategies have been shown to be helpful in treating patients with CBSD (for review see: [46]). Patients could further benefit from third-wave behavioral treatments such as mindfulness-based therapy [47] or from adjunct neurocognitive approaches such as inhibitory control and cognitive bias modification trainings [48].

Limitations

The summarized studies and hence this systematic review have several limitations. First, small sample sizes in some studies limit the statistical power of their findings and might be a possible reason for failure to report differences between individuals with CBSD and healthy control participants [49, 50]. Second, convenience samples of some studies partly relied on college or university student samples imposing further constraints for external validity [51]. However, using predefined convenience samples represents an adequate attempt to explore research questions and serve planning studies in clinical samples. Third, the number of studies in some of the cognitive areas (e.g., PIT, implicit associations) is limited hindering conclusions that can be drawn from these sections. Lastly, Fig. 1 must be interpreted with caution, given the fact that the included studies differ regarding the methodology (i.e., sample size, convenience vs. clinical sample, neutral cues vs. shopping-specific cues).

Future Directions

The examination of psychophysiological and neural correlates of affective and cognitive mechanisms of CBSD would contribute to a better understanding of the phenomenon. In addition, more studies are required that differentiate between general cognitive deficits and specific affective and cognitive alterations in response to buying-shopping-related stimuli. As suggested in the I-PACE model for addictive behaviors [11•], specific stimulus-related inhibitory control deficits are considered especially relevant in later stages of the addiction process. In line with this, future studies should aim at investigating clinical samples and/or samples at a large scale showing risky and pathological behaviors. Longitudinal studies would help to explore trajectories of underlying cognitive mechanisms and draw causal interpretations regarding the direction of interactions between cognitive processes and symptoms of CBSD. Moreover, potential tertiary or external aspects that might influence CBSD such as stress vulnerability, genetic predispositions, or context variables should be considered, as well as comorbidity with other mental disorders.

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Declarations

Conflict of Interest The authors declare no competing interests.

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Papers of particular interest, published recently, have been highlighted as:
• Of importance
•• Of major importance

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