Habit-Formation as a Mechanism of Action in Cognitive Adaptation Training

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ABSTRACT

Cognitive Adaptation Training (CAT) is an effective psychosocial treatment for serious behavioral health conditions that uses environmental supports such as signs and checklists to cue and sequence adaptive behavior in the home environment and improve functional outcomes. CAT has been found to improve targeted behaviors, role functioning, and community tenure in multiple randomized trials. While CAT has been shown to improve cognition after 12 months, initial improvements in target behaviors and functional outcomes are not attributable to improved cognition. This article describes a putative mechanism of action for CAT based on dual process theory. Improvement in CAT treatment is proposed to result from continued paring of cues (context situations) with behavior that leads to automatic behaviors and habit formation that bypasses cognitive and motivational problems typically associated with serious behavioral health conditions. Data that examine habit formation using automatic processes is presented to support the proposed mechanism of action.

KEYWORDS

[cognitive adaptation habit formation serious mental illness]

Serious behavioral health challenges such as schizophrenia, schizoaffective disorder, and mood disorders are among the top disabling conditions worldwide (Satcher, 2000). These illnesses are often characterized by functional impairments in major role activities such as work, socialization, and independent living skills (Green et al., 2000; Maples & Velligan, 2008). Difficulties with motivation and cognitive processing related to attention, memory, and executive functions are often present and have been found to underly difficulties observed in role functioning (Green et al.,

Fig. 1: CAT intervention examples

2000). While medication treatments have been found to improve symptoms including hallucinations, delusional thoughts, mood disturbance, and impulsivity, medications have not been sufficient to improve functional outcomes for this population. To improve outcomes in areas of unmet therapeutic need, psychosocial treatments have been developed and tested to improve community functioning and quality of life for those with serious behavioral health challenges.

Cognitive Adaptation Training (CAT) is a psychosocial treatment designed to bypass the cognitive and motivational difficulties often experienced by individuals with serious behavioral health challenges in an effort to improve functional outcomes (Velligan, Diamond, Maples, et al., 2008; Velligan, Diamond, Mintz, et al., 2008). CAT uses environmental supports or compensatory strategies to cue and sequence adaptive behavior in the person's home and work environments. Examples of CAT interventions include voice alarms, checklists, schedules, customized pill containers, text messages, organizational supplies such as hampers, drawers and file boxes, and the re-organization of belongings. See Figure 1 for examples (Maples & Velligan, 2008).

CAT interventions target multiple domains of adaptive functioning and are based on a comprehensive assessment of the individual's cognitive functioning, their typical behavioral style when completing goal-directed activity (apathy, disinhibition, both), their current functional ability (what they can and cannot do as well as what they actually do), and their environment (Maples & Velligan, 2008). Environmental cues, created based on assessment outcomes, are established and maintained during weekly home visits by a CAT provider. CAT treatment typically lasts for nine

months followed by booster sessions to maintain treatment gains (Velligan, Diamond, Maples, et al., 2008).

Decades of research across multiple countries provide empirical support for CAT as a psychosocial intervention that significantly improves medication follow through, targeted independent living skills, hours worked, and motivation and reduces the risk of relapse and rehospitalization (Allott et al., 2017; Kidd et al., 2014; Quee et al., 2012; Stiekema et al., 2020; Velligan, Diamond, Maples, et al., 2008; Velligan, Diamond, Mintz, et al., 2008; Velligan et al., 2015). CAT has been successfully used in statewide programs in Texas to help those with serious behavioral health challenges relocate from nursing homes to more independent community settings (Maples, 2018). In addition, CAT is successfully being used in value-based programs in managed care Medicaid to reduce hospitalization and improve community functioning in those with high utilization of hospital and emergency department services (Velligan et al., 2022).

While supports are designed to compensate for problems in cognition and motivation, the mechanisms of action for how CAT improves functional behaviors have not been discussed much in the literature. Cognition does not improve until late in treatment for participants in CAT even though multiple domains of functional outcome improve much earlier (Fredrick et al., 2015). This later stage improvement in cognitive performance has been described as a "bottom up" improvement where increased engagement in independent living activities and improved social/role functioning leads to improved cognitive performance over time. Since CAT is compensatory in nature and is not designed to improve or restore cognition directly, these results are not surprising. How then is CAT thought to work to improve functional outcomes early in treatment? In this article, we describe a putative mechanism for the efficacy of CAT. We outline a model for the development and maintenance of functional behaviors and discuss available evidence to support this proposition.

Dual Process Theory

According to dual process theory, behavior is impacted by two general processes known as controlled and automatic processes (Ouellette & Wood, 1998; Wood et al., 2014). Controlled processes refer to processes that are under the subject's awareness, intention, and conscious control. Controlled processes are relatively inefficient and labor-intensive, requir-

ing a great deal of conscious effort and attention. For example, learning a new skill such as driving represents a set of behaviors executed using controlled processing. It takes a new learner a great deal of focus to remember to check their mirrors, decelerate into a turn and accelerate out of a turn, use their turn signals, keep aware of the current speed limit, and be ready to respond to unusual maneuvers of other drivers or pedestrians. In contrast, automatic processes occur outside of the subject's awareness, control, and intention. Automatic processes are highly efficient, fast, and use minimal cognitive resources. An example of automatic processes includes the set of behaviors executed while driving after a lot of practice. In this case, well-practiced behaviors involved in driving become automatic and proceed without much conscious awareness. It is common for people to find they have arrived at their destination with little awareness of the individual behaviors they engaged in during the drive. In fact, the majority of repetitive day-to-day human behavior is guided by automatic processes (Bargh & Morsella, 2008). This distinction between automatic and controlled processes has been applied to how we develop and execute habitual behaviors (Wood et al., 2014).

CAT Theoretical Model

We propose a theoretical model for the efficacy of CAT based on dual process theory in which repeated behaviors lead to habit formation and finally to automaticity in performance of a behavior. In other words, behaviors that may start out as performed using controlled processes become increasingly automatic in response to specific CAT supports or cues in the environment that promote repeated task initiation and maintenance. This habit formation leads to specific adaptive behaviors being regularly and repeatedly performed, in turn leading to the overall improvement in social and role functioning seen in CAT.

According to Wood et al., habits are formed when an individual repeats the same behavior in the same situation over and over (2014). The behavior becomes associated with the cues that are present in the situation each time the behavior is executed (i.e., contextual cues). After a time, those cues come to elicit or trigger the behavior. Many of us have experienced how difficult it is not to look at your phone when you hear a tone indicating that a text message has arrived. It takes conscious effort, that is controlled cognitive processes, to override this automatic response. Auto-

matic behaviors are often cued by situations in the environment. For example, it is not unusual for individuals who are not paying attention to follow people off an elevator at the wrong floor. The door opens, people leave, and this serves as a strong contextual cue to exit the elevator. Using environmental cues analogous to cell-phone text notifications, CAT uses automatic processing of established environmental cues to form positive, regular habits that can impact global functional outcomes.

The associations between contexts and behavior are stored in memory (Lally & Gardner, 2013). When a specific context is repeatedly paired with a behavior, that association becomes strengthened in memory, and exposure to the context can serve as a prompt that initiates the behavior. The stronger the association, the more easily the behavioral cue is accessed and the more powerfully the behavior is cued. Strong contextual cues, accomplished through paired repetition of context and behavior, result in a high probability of the cue prompting a specified behavior.

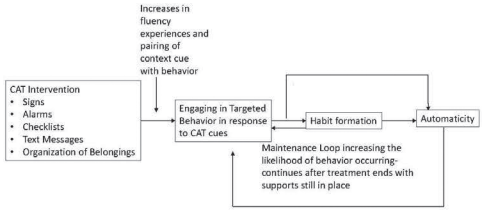
Although individuals perform behaviors in response to cues, according to Wood et al., over time, an individual may begin to attribute their performance of that cued behavior as coming from their own desire to engage in that behavior rather than from the simple presence of the cue (2014). As a behavior is completed over and over in response to a specific context, that behavior approaches automation, and the individual's desire is not necessary to elicit the behavior. This is a key notion in serious behavioral health conditions where motivation to perform important behavior is often diminished.

Understanding the way in which cues come to elicit behavior and bypass conscious motivation provides a pathway to helping individuals with both cognitive and motivational challenges or impairments. CAT capitalizes on contextual cues to signal the activation of a specific behavior. These cues may be voice alarms recorded in the person's voice reporting the time and the person's goal. For example, "it's noon I wanted to walk to improve my health, it's time to put on my walking shoes." Placing items exactly where and when they are needed to trigger behavior is another example of working with context to cue the appropriate behavior. The placement of walking shoes right by the door or placing toothpaste and a toothbrush near the mirror in the bathroom to prompt their use are examples. Another is placing medication taken at night in a container right by the bed with bottles of water, so that the presence of these environmental supports can

cue taking medication before bed. Checklists and signs also form a context that with repeated use can promote behavioral automation leading to habitual behavior. CAT uses all these types of contextual cues together to increase the likelihood that adaptive behaviors will be performed in the presence of the cue.

According to Wood et al., reinforcement or reward for the initial pairings of the context with the behavior increase the likelihood of early response (2014). However, it is likely that these reinforcements won't need to be maintained as the behavior approaches habit and automaticity. In CAT, rewards are often used initially to increase the likelihood that behaviors will be performed in the cue context. Once habits are formed, however, rewards are decreased in frequency and eventually terminated. The goal in CAT is to make adaptive behaviors as automatic as possible so that they are reliably elicited by the cues in the person's environment. This process may bypass not only cognitive issues (trouble getting an idea, remembering or formulating needed steps) but also motivational issues (difficulty putting in needed effort).

Several principles apply to creating habits and automatic behaviors in CAT. Priming and fluency are examples. Priming is defined as what happens when exposure to one stimulus influences a response to a subsequent stimulus (Légal et al., 2016). Priming can occur automatically without conscious intention. CAT environmental supports are designed to create a readiness in the individual to respond to the next or another cue. Multiple cues placed throughout the person's environment are set up to occur in sequence either by location (moving from bedroom to bathroom to living room) or by time (8 a.m., 9:30 a.m., noon, etc.). The first of these cues each day primes the individual to respond to the next cue. Fluency refers to the ease with which something is processed. Prior exposure to a stimulus makes that stimulus easier to perceive and process. Over time this creates a sense of liking. Cues in the environment become easy to process, and the individual engages in cued behavior in a way that seems easy and truthful. CAT environmental supports are designed to create this feeling of ease or fluency and reduce the feeling of effortful processing. For example, when nighttime medication is placed right by the bed and an alarm reminds the individual to take it at the time they are getting into bed, it feels easy and right to engage in the cued behavior. These principles allow the cues to take hold and the behaviors to be perceived positively. This feeling of liking then reinforces responding to the cues again.



Fig, 2: How Cognitive Adaptation Training may create habitual behaviors

The use of antecedent control strategies to increase priming and fluency experiences minimizes the effort needed for behavior change and helps individuals to develop and sustain new adaptive habits that form the foundation to improve social and role functioning and promote recovery. The theoretical model for how CAT creates habits and automaticity in behavior appears in Figure 2. The use of environmental supports in the same way at the same time repeated over and over leads to the formation of habits and automatizes behavior, thereby bypassing both cognitive and motivational impairments. Over time a maintenance loop forms that sustains the behavior with the cues when treatment is ended.

Evidence to Support the Model

With respect to CAT specifically, evidence from a few initial studies provides some support for the model described above. As previously discussed, the mechanism of action for improvement in functioning is not improvement in cognition. Temporally, improvement in functional outcome precedes improvement in cognitive function. There are data from an early study indicating the use of provided supports increases the likelihood of targeted behavior change (Velligan et al., 2009). In that study, individuals with schizophrenia/schizoaffective disorder were randomized to CAT, to receive a package of generic environmental supports (GES) that included signs for medication reminders, checklists for daily activities, bus passes for getting around, hygiene products, and pill containers, or community treatment as usual (TAU). In the GES group, participants met with a CAT provider once at the clinic, discussed the use of the supports and where to place them at home, and received a tape recorder and recording of this interaction to remind them how to use and where to place the items.

During the study, an independent researcher contacted all participants in CAT and GES and asked them if, when, and how they used the specific supports provided. Group differences were investigated during the initial three-months post-randomization. Results indicated that both CAT and GES improved functional outcome relative to TAU, that CAT improved target behaviors to a greater extent than GES or TAU, and that GES improved target behaviors more than TAU. In addition, both CAT and GES participants who used supports to a greater extent improved more in target behaviors. The results of the study indicate the importance of using the supports provided or from a habit formation perspective, continued pairing of the cue context with the behavior. While not direct evidence, the results of the study support the ideas regarding mechanisms of action.

In another study, 95 participants with schizophrenia/schizoaffective disorders were randomized to CAT, PharmCAT (CAT treatment applied only to medication follow-through), and TAU (community treatment as usual) for a period of nine months and then followed for six additional months post-treatment (Velligan, Diamond, Mintz, et al., 2008). Results of this study demonstrated that both CAT and PharmCAT improved adherence to medication (as assessed with unannounced in-home pill counts) compared to TAU. Moreover, when treatment was withdrawn at nine months, adherence to medication remained consistently higher in CAT and PharmCAT than in TAU. Results of the study provide some evidence that a specific behavior such as taking medication every day in the same context in response to the same environmental cues can create a habit that is sustained following treatment withdrawal. It is interesting to note that more global functioning began to decrease following treatment withdrawal, unlike the more circumscribed behavioral target of adherence to oral medication.

The most direct evidence that CAT exercises its impact based on habit formation comes from a small study (n = 17) of the Helpful Habit program (Docherty et al., 2016). This program was a telephone-delivered program using environmental supports based on CAT. Master's level nurses and case managers contacted participants several times weekly, identified medications taken and prescription directions, identified daily habits (e.g., drinking coffee in the morning) that they could link to taking medication, mailed a kit to participants containing pill containers, calendars, stickers, and other helpful supports, and discussed with individuals where to place

and how to use supports during calls several times weekly. In addition, participants could elect to receive text message reminders. Adherence was assessed by independent researchers using pill counts conducted weekly at home. Habit strength and automaticity were assessed at baseline and weekly during the intervention. Results of this pilot program indicated that habit strength as assessed using the Self-reported Habit Index and Automaticity (a sub-set of items reflecting the degree to which taking medication was automatic) significantly increased over the course of treatment (Verplanken & Orbell, 2003). While the study is small and there was no control group, this is the first evidence that habit strength and automaticity were increased using CAT interventions. In summary, for CAT specifically, there is only limited empirical data supporting habit formation as a mechanism of action and other than clinical impressions, no data to support that the use of CAT supports changes an individual's sense of "liking."

In addition to studies examining CAT, studies of habit formation in a variety of fields have investigated increasing habit strength and automaticity during behavior change. For example, in studies on weight loss, (Beeken et al., 2017; Lally et al., 2008) were able to demonstrate that using a habit formation approach in which participants were given information on routinization and cuing led to greater weight loss with maintenance than a control condition (Beeken et al., 2017; Lally et al., 2008). Furthermore, habit formation and habit changing interventions have successfully improved physical activity, diet, and food safety (Gardner, 2015).

At least two studies have called into question the use of cuing for building habits. In a study of 200 individuals randomized to one of four groups in an information only, information and cue, information + action plan, and information+cue+action plan, the cues condition led to lower hearing aid use than other groups (Ismail et al., 2022). In this case the cue or prompt used was a reminder to place the box in a prominent location such as next to the bed. While this might be part of a CAT cue, CAT would have involved refinement, customization, and multiple cues. The box, which may be generic, would have a picture of an ear. A text reminder or electronic alarm would add an additional layer. Moreover, a behavioral analysis would have been much like an action plan. The goal of CAT would not be for the individual to wear their hearing aids when alone at home but for listening to television, in conversation, in doctor's visits, and engaging in other activities where being able to hear is important. Cues

would be customized to situations such as these (e.g., a note on the back of the door reminding the person not to leave without their hearing aids). A second study attempted to get people to microwave their dishcloth or sponge. One condition used a poster placed in the kitchen (Mergelsberg et al., 2021). Results indicated that cues did not impact behavior. Again, the cueing in the study was less intensive than cues that would be used in CAT. In CAT, if this were a desired change, the microwave door would have a sticky reminding the individual to engage in the behavior. In addition, a text or electronic reminder would be sent or established (e.g., Alexa: "it is time to microwave your dishcloth."). These studies in which cueing was not helpful suggest that customization, salience, redundancy, and timing may be important to consider when using cues to elicit behavior.

Despite the seemingly contradictory studies above, behavior change treatments targeting context-behavior associations and repetition have been successful in promoting specific healthy behaviors. Multiple studies have been able to link behavior change in target behavior to self-reported increases in habit strength and automaticity. While CAT uses contextual cues and repetition to promote daily behavior change in specific behavioral targets, how does this change in circumscribed behaviors lead to improved global functioning and daily activity? It appears that CAT may help individuals form a network of connected habits that chained together impact higher level functional processes. Moreover, CAT usually begins with simple behavior where early success can form the foundation for greater behavior change.

Conclusions

Habit-formation and automaticity are likely to underly the effectiveness of CAT. Data suggest that repeated context-behavior pairings can change micro-behaviors that in a network of connected habits can lead to global functional improvements. However, evidence is limited. Further, research should examine the mechanisms underlying behavior change looking specifically at habit strength and automaticity. In addition, examining whether there are changes in "liking" and feelings of fluency should be examined. Moreover, future research should compare CAT with non-habit interventions with the same behavioral targets to elucidate this potential mechanism of action more clearly. In such an experiment, changes in both groups in experiences of automaticity, fluency, and liking could be exam-

ined. Finally, alternative mechanisms of action underlying the changes seen in CAT should be explored. Social reinforcement by the CAT therapist/trainer or from individuals in the person's environment that notice changes in hygiene and adaptive behaviors may underlie the effectiveness of CAT. Self-efficacy experienced as a result of accomplishments that begin small and build within the CAT program is another potential mechanism that could be explored in future research.

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