

## SUPPLEMENTARY MATERIAL

Kim JW, et al. Advanced cognitive-behavioral treatment model with exposure–response prevention for treating obsessive-compulsive disorder

This supplementary material has been provided by the authors to give readers additional information about their work.

### OCD and learning theory

The most supported neural and pathophysiological model of OCD focuses on overactivation of the cortico-striato-thalamo-cortical circuits.<sup>1</sup> According to this model, the orbitofrontal-subcortical pathway is hyperactive in OCD patients compared to healthy people, resulting in a change in the reinforcement contingencies of stimuli. Due to this change in reinforcement contingency, when OCD patients suffer from an obsession, they engage in some kind of behavior that reduces the anxiety or distress. Finally, they come to believe that this behavior is the solution to the obsession, and this learned behavior eventually becomes a compulsion.

### Obsession and classical conditioning

CBT is a time-limited, structured, and active psychological treatment, and ERP is its main form of application in cases of OCD.<sup>2</sup> ERP treatment for OCD begins with understanding the formation of the obsession and compulsion by applying learning theory (classical conditioning and operant conditioning).<sup>3–5</sup> Classical conditioning theory suggests that, in OCD patients, a neutral stimulus can be overgeneralized and become a CS that evokes obsession.<sup>4,6</sup> For example, a patient who has an obsession with contamination fears contamination by stimuli that healthy people would not think are dirty. Understanding classical conditioning while performing the therapy is helpful when planning ERP therapy. As a form of directive psychotherapy, ERP can be more effective if the therapist understands the factors (who, when, where, what, and how) that cause the obsession and can therefore clarify all aspects of the obsessive pattern, i.e., the CS, unconditioned stimulus (US), unconditioned response (UR), and conditioned response (CR).

### Compulsion and operant conditioning

The formation of a compulsion can be explained by the theory of operant conditioning.<sup>5</sup> The Skinner box became an important tool for studying learned behavior and contributed a great deal to our understanding of the effects of reinforcement and punishment. OCD patients judge that a ritual behavior relieves the anxiety or distress caused by an obsession. This belief leads them to engage in the behavior, which is then reinforced, increasing the likelihood that the compulsive behavior will occur again when the obsession recurs.<sup>1</sup> For example, patients repeatedly wash their hands to reduce anxiety whenever they think their hands are dirty or contaminated. Operant conditioning is also applied to understand the mechanism of habituation when carrying out ERP treatment. ERP approaches are habituation-based models that emphasize reduction in fear through the exposure and response-prevention process as essential for reducing symptoms.

### Limitation of learning theory

Classical and operant conditioning help to explain how OC symptoms are formed and how they can be treated, but there are some limitations. First, both theories have used animal models to explain principles that are then applied to human behavior, including that of psychiatric patients. OCD is a major disease of thoughts and behaviors. Thus, it is difficult to use animal models to fully describe the cognitive aspect of the disease. Second, the theories do not fully explain OCD. Classical conditioning explains how a neutral stimulus causes the obsession, but it does not explain formation of the compulsion. More specifically, in classical conditioning, the response takes the form of a reflex. For example, if a dog salivates after seeing food and/or hearing the sound of a bell, the saliva is not controlled by the dog, but is automatically secreted. However, compulsion is not a reflexive response but a behavior selected (intended) spontaneously by the OCD patient to avoid anxiety or distress deriving from the obsession (motivation). In conclusion, classical conditioning theory alone does not explain how patients learn compulsive behaviors. In contrast, operant conditioning explains the formation of a compulsive behavior relatively well, but it does not explain the association between the obsession and the CS. Finally, the two theories cannot explain the definition contained in criterion B of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5): “The obsessions and compulsions are time-consuming (e.g., take more than 1 hour per day).”<sup>7</sup> In other words, they cannot elucidate the frequency or duration of the patient’s compulsive behavior. Although patients exhibit a compulsion to relieve the anxiety caused by the obsession when neutral stimuli are applied, it is impossible, using these two theo-

ries, to explain why they repeatedly exhibit compulsive behavior. For example, when a patient obsessively washes their hands due to a contamination obsession, they should stop washing them and perform other tasks if the hands are clearly washed. Compared to normal subjects, who wash their hands for 1 minute, OCD patients show compulsive washing behavior, several times or for much longer periods. Thus, they cannot stop continuous washing behavior, even after the stimuli that triggered the obsession are removed.

## Case

### Contamination and washing case

Mr. A, a 48-year-old entrepreneur, was seen at another hospital for ERP treatment. He had an obsession with contamination that lasted 4–5 hours/day, and he took 10–30 minutes to wash each hand to relieve the compulsion. He was upset that he could not stop washing and was unable to control his symptoms after 20 minutes of washing his hands. Although he had suffered from this obsession since he was in elementary school, he had not received any therapy. When he was 41 (7 years ago), he presented at another hospital, where he was prescribed medication, as recommended by his wife. He was prescribed 20 mg escitalopram and 0.5 mg alprazolam, and his symptoms were controlled to the extent that others could not identify them. When the washing behavior reappeared 7 months before he came to our hospital and was uncontrolled, he became angry, struck a mirror with his hand, and broke his wrist. He visited a tertiary care hospital due to the severity of the injury. The doctor adjusted his medication to control his obsession and impulsiveness (40 mg escitalopram, 1.5 mg risperidone, 0.5 mg clonazepam, and 0.25 mg alprazolam), but his distress declined by only about 20%. Although he began to take 200 mg sertraline, 5 mg aripiprazole, 25 mg clomipramine, 0.5 mg clonazepam, and 2 mg diazepam when the previous drugs proved ineffective, he was referred for ERP therapy, as his symptoms had not significantly improved. We prepared for ERP therapy while adjusting the dosages of medications over a 3-week period to 300 mg sertraline, 5 mg aripiprazole, 0.5 mg clonazepam, and 50 mg fluvoxamine. During the process of exploring and evaluating the patient's OCD symptoms [Yale-Brown Obsessive-Compulsive scale (YBOCS) score: 34], psychoeducation about OCD and treatments was conducted. In particular, the patient had a history of uncontrolled anger and had hurt his wrist as a result, so education designed to keep him from engaging in compulsive washing was implemented, although his urge and distress were not abated. He made an effort to learn how to control the urges. Three weeks after the initial treatment phase, he said that he had 60% discomfort compared to baseline, and we began exposure therapy. Four sessions of exposure therapy were conducted. After the first habituation session, he reported that he was motivated to pursue the therapy. After session 2, he said that he should wash his hands if he felt sticky, but that washing only for 3 minutes was sufficient to stop the behavior. One week after session 4, he was satisfied with the therapy, as his discomfort score after the therapy was about 20, so he discontinued the behavioral therapy (YBOCS score: 6). He now reports that, 6 months later, his symptoms are stably controlled without further ERP therapy, and he now takes 200 mg sertraline and 50 mg fluvoxamine.

### Doubt and checking behavior case

Mr. B, a 20-year-old college student, was referred to another hospital for ERP treatment. He spent more than 2 hours/day checking whether his wallet was lost, and expressed concern about others' watching such behavior. For the past 3 years, he worried that he had dropped his wallet whenever he hit a door or got up from a chair. At first, he just turned his head and checked the chair to verify that he had his wallet, but he gradually extended his ritualistic behavior, as such behavior did not reduce his anxiety. He regarded it as a tic and was distressed, because he could not control it. When he visited a therapist, the ritualistic behavior he performed whenever he sat down and stood up was extended. The order and contents of the ritual were as follows: take a long breath → open eyes wide → look left and right → close eyes → take a breath → recite the numbers 111-11-1111-12345 → clench teeth together → shake head. The therapist judged that the ritualistic behavior was a compulsion to reduce the obsession with losing his wallet, and recommended ERP therapy. The therapist began by conducting exploration and education about medication and ERP across three sessions. However, Mr. B did not experience habituation and had a difficult time suppressing his compulsion for 90 minutes. Therefore, the therapist extended the number of exposure sessions to two per week to increase the effects of the ERP therapy. However, Mr. B asked to stop the therapy in the middle of a session because of his distress. In addition, he reported that his interpersonal skills and ability to control stress had decreased and that his compulsive symptoms were exacerbated whenever he got depressed due to stressful life events. The therapist determined that outpatient treatment would not have significant effects and recommended hospital treatment. The patient was hospitalized and received therapy for 26 days. His medications were adjusted (200 mg fluvoxamine, 75 mg venlafaxine, 2 mg aripiprazole, 0.25 mg clonazepam, 25 mg trazodone, and 40 mg propranolol), and he underwent more intensive exposure therapy. The therapist repeatedly conducted psychoeducation to help him learn that his behavior was not a tic but a com-

pulsion that he could suppress. The frequency of the compulsion decreased as he gradually realized that he could control his behavior, making him less concerned about others' watching him, and leading to improvement in his depression. When he was discharged from the hospital, his YBOCS score was 11.

## REFERENCES

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