

Instrumental Behavior in Pavlovian-instrumental Transfer for Depression Therapy

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Abstract: The mental condition is closely linked with people's instrumental behavior, which allows us to adapt to the external environment. Rely on the positive valence system, the habits and goal or value seeking behavior is linked with the instrumental behavior and the influence of environmental cues. While depression patients build up an aversive Pavlovian-instrumental transfer and form a biased emotional state. The Pavlovian-to-instrumental transfer (PIT) was influenced by the environment and was reflected in biological chemistry level. Also, in the safety learning and exposure therapy, instrumental behavior has become a fundamental factor of generation of safety signals to help ease fear and anxiety. It makes exposure therapy possible. All of them are revealing that by changing instrumental behavior, it may be able to change patients' mental condition and contribute to depression therapy. In the future, simple and effective instrumental behavior may be able to get into therapy and recover procedure of all kinds of mental disorders.

Keywords: instrumental behavior, depression therapy, environmental cues, Pavlovian-instrumental transfer (PIT), positive valence system

1. Introduction

Pavlovian-to-instrumental transfer (PIT) is a naturally occurring phenomenon: individuals integrate environmental information to act and make decisions. [1]

Environmental cues can contribute to or suppress adaptive behaviors, but sometimes they may influence irrelevant instrumental behavior by PIT: invigorating instrumental behavior with Pavlovian cues. [2] People interact with environmental cues and make adaptive behaviors, [2] when such PIT is disrupted [3] or an enhanced aversive PIT suppresses the appetitive one [2], it will contribute to depression or other psychological disorders.

This paper will explain the interaction between the PIT mechanism and the other factors that are influenced by PIT or depression development, such as emotion changes, biological neurotransmitter changes, and then pathological patterns.

There is still no evidence that appetitive Pavlovian-instrumental transfer (PIT) will directly encourage the development of depression. [3] During the 3 phases of PIT transfer, participants first associate the motivational stimuli with instrumental behavior and then associate the Pavlovian cue with the motivational stimuli. In the final transfer phase, they will respond to the Pavlovian cue with an instrumental behavior, even without motivational stimuli.

Motivational characteristics of Pavlovian predictors influenced the vigor of instrumental action, which was formerly independent of Pavlovian associations. A reward-associated Pavlovian cue enhanced instrumental responding in the transfer phase. That is how PIT transfer is established.

As for the aversive PIT, in some conditions, the passively learned depressive experiences (an unhappy social activity, or a failure in an exam) as aversive Pavlovian stimuli may be associated with biased passive emotions, which lead to withdrawal instrumental behaviors. [2]

Both the disruption and enhanced aversive PIT are thought to be a contributor to mental disorders.

In depression development, the PIT also interacts with emotional, biological, and pathological factors, which reveals a deeper relation between PIT and depression. For example, serotonin is thought to inhibit actions if punishment occurs, and the exaggeration of aversive Pavlovian cues promotes negative ideation, and the anxiety and anhedonia issues on the PIT perspective. [4]

The role instrumental behavior act in the depression process is so complex that it makes me wonder: Will people get mental disorders of some behavior? If it's true, what specific kind of action will contribute to depression, and how does it work? Is it possible take advantage of the mechanism and aversively alter the depression situation? Are there some current therapies that involve some behavior-based methods to treat instead of using some medicines with side effects? This paper will be a literature review intended to conclude and answer these questions.

Finally, the possibility to apply the mentioned mechanism to clinical therapies will be concluded. For example, environmental therapy, safety learning, exposure therapy [5], and anhedonia treatment.

2. Disruption in appetitive Pavlovian-instrumental transfer (PIT) and anhedonia

The appetitive PIT helps people to normally conduct their daily life, by allowing them to adapt to the external environments. According to the “positive valence system”, adaptive behaviors originate from a system that is sensitive to external changes, which modulates and activates motivational states. [6] Together with input external sensory, the motivational states pave the way for generating Pavlovian conditioning.

Disruption in appetitive PIT seems to break the reinforced instrumental behavior, which will lead to difficulty in habit forming. It has been observed that the reinforcement sensitivity theory has proposed that the sensitivity of reward and punishment in different people is different to some extent. [7].

This paper assume that it is the difference in instrumental behaviors people used to behave that form their difference in perceiving reward and punishment. Their cognition of instrumental behavior and the results can be shaped: if one keep practicing some behaviors and constantly get positive feedback, he can perceive these behaviors as rewarding and thus form thinking of worthy and confident; otherwise, if one practices other behaviors that always gives a negative feedback, he can perceive those behaviors as worthless, thus prohibiting a think of not confident; however, if one get punishment feedback, he can perceive such behavior as harmful, thus leading to withdrawal behavior or suppression of former behavior.

The reinforcement learning generated by the PIT participates in the formation of habits. The enhancement of reward-seeking behavioral habits may have benefits in building an unconscious but behavioral approach to reward.

While a disruption that blocks the appetitive PIT is thought to contribute to anhedonia. [3] Since anhedonia is caused by reward sensitivity loss, and the appetitive PIT is above all a mechanism to generate adaptive behavior, when the body successfully conducts an adaptive behavior, the positive valence system will make an emotional positive response. [6]

When this appetitive PIT was disrupted, the healthy circulation of self-adapting was broken down. For example, by not responding to the water when thirsty, the Pavlovian cues no longer arouse us to

make reward-seeking behavior. The breakdown disrupts the reward value generation and further lowers the amount of reward sense perceived, which leads to a decrease in the sensitivity of pleasure.

It can be known that the reward perception is negatively linked with the reward-seeking behavior. Given the pleasure perception is reduced, the disrupted unhealthy PIT still leads to a declined desire to seek pleasure. It is reasonable to hypothesize that not only the increase in reward value will mediate reward-seeking behavior but also the disrupted reward perception can reduce desire for pleasure and lead to anhedonia.

3. Aversive Pavlovian-instrumental transfer (PIT) in depression

The PIT plays an important role in people's adaptation to surroundings. But does aversive PIT that inhibits instrumental behavior act the same? It is known that depression patients are profoundly influenced by exaggerated aversive PIT which enhances aversive PIT suppresses appetitive PIT and provides a potential cognitive mechanism for biased emotion processing in MDD (major depressive disorders). [2] That's why patients exaggerate the negative environmental stimuli, making it difficult to get rid of feeling sick and withdraw from things they dislike.

If one succeeded in associating beneficial environment cues with rewards, he/she may have had greater chances of survival in ancient times. When people are faced with difficulties in modern society, some take instrumental approach action to achieve their goals of conquering them, but some take instrumental withdrawal action to avoid the trouble. The Pavlovian cues involved are then differently assessed and transformed into goal/reward value or signal of potential harm.

When an individual fails to adapt behaviors, the aversive PIT forms the passive habit of withdrawal just like that in the appetitive one. This reinforces the behavior and makes it more likely to be repeated in the future, which explains why the inhibition of instrumental behavior goes to extremes and ends up forming biased emotional responses, and is difficult to remove or change. That may explain why small cognitive changes will lead to great results if they can be enhanced and continue for a long period to be rooted in one's mind.

It is obvious that the biased association is partly generated by the depressive experience, but the stimuli themselves don't lead to psychological disorder. It is the kind of PIT transfer that humans establish counts. In other words, the way people recognize the world makes up their mental world and influences their mental health.

4. Serotonin in aversive Pavlovian-instrumental transfer (PIT)

Serotonin is an important biological factor in decision-making process inside the brain, by interacting with the appetitive and aversive PIT. The experiment uses a tryptophan-depleting drink (TRP) and a balanced amino acid drink (BAL) as the control group (the BAL doesn't contain TRP) to detect serotonin decline arousal by acute tryptophan depletion (ATD) among participants. [4] To put it simply, the TRP caused ATD and led to serotonin decline.

The result finds that ATD disinhibits aversive Pavlovian conditional stimuli (CS) over instrumental behavior. but does not affect appetitive ones. Also, for the instrumental behavior, when the "go" behavior is correct, disinhibition is apparent compared to "no go". It also proposed that the mechanism may have something to do with punishment anticipation.

Serotonin lowered by ATD proved the relation between aversive PIT and serotonin. Given that serotonin is thought to inhibit actions if punishment occurs, and the serotonin-caused inhibition of aversive Pavlovian CS, the lack of serotonin may be a contributor to depression. It has been already known that the aversive PIT is significant to everyone's cognitive perception of negative experiences and that ATD disinhibits punishment anticipation. [8] This paper predict that the aversive PIT will be enhanced in case of serotonin level declines, and the punishment anticipation will be strengthened.

In that case, depression patients may perceive an overexposure to fear of punishment. In that way, they may be biased and perceive the surroundings as aggressive.

The feeling of not being safe may cause a sense of anxiety and increase the aversive Pavlovian cues which will lead to biased negative emotions. This inspires us to pay more attention to biological patterns that indicate early psychological disorders such as lower serotonin levels. [9]

Moreover, it is worth investigating whether increasing serotonin levels intentionally by using medicines can ease depression symptoms. The difference in serotonin levels in different groups is possible since individual differences in punishment and pleasure anticipation do exist, which calls for a systematic exam of the specific level of personal depression condition and serotonin.

5. Pavlovian-instrumental transfer (PIT) with emotion change in depression

Computational theories of valuation provide a quantitative framework linking emotions to choices. [10] It has been found out that in the PIT transfer, emotion plays an important role in generating reward values, or it becomes biased and leads to depression. In the interaction of the PIT and emotion, the cognitive mechanism of reward searching and punishment avoidance has been influenced by emotional responses, which were caused by PIT transfer.

Such transition between action and mind indicates why internal choices about what to think about are in many ways similar to external actions about what to do [11;12], and internal mental conditions have been proved to interact with external action in this way.

From the action-specific view, the appetitive conditional stimulus (CSs) active approach and aversive CSs active withdrawal behavior. Such a phenomenon occurs only in healthy and recovered depression groups. [13] In addition, the failures in the PIT as Pavlovian cues causing both approach and withdrawal instrumental behaviors might have consequences for the internal working of other aspects of emotion.

It has been widely accepted that 2 weeks of bad mood could be identified as a potential beginning of depression. Given the aversive PIT effect on inhibiting instrumental behavior and the action-specific loss, this paper hypothesize that emotion modulation can be influenced by instrumental behavior. Because a suppression of instrumental behavior occurs at the same time as biased emotional cognition.

This could provide a method to reverse biased cognition by practicing instrumental behavior to trigger positive emotions and add to reward sense according to the “positive valence system”, which could be a supportive approach to help depression recovery. Moreover, it is also important to intentionally interfere with negative emotions, and instrumental behavior based on positive emotions may help modulate the emotion.

6. Pavlovian-instrumental transfer (PIT) with stressful environmental cues in depression

From the embodied hypothesis in cognitive psychology, people’s internal conditions are closely related to their surroundings, their self-assessment, and their actions together with specific body shape. The negative environmental cue input in the PIT stage may be responsible for mental disorders.

Among depression patients, the exaggerated promotion of negative ideation may be caused by a stressful environment. There has been evidence that stress interacts with the impact of environmental cues on behavior. [14] Also, the stressful experiences brought by the environment are thought to have a fundamental impact on brain development, leading to long-term functional risk for mental health outcomes. [15]

It is obvious that during the progress of depression, the environmental cue plays an important role. External care may be not so important for adults since the valance systems have been comprehensively formed. But for children, a safe and positive environment is necessary. In the

situation of depression, a negative environmental cue may not be strong enough to cause depression, but what if there's a lot? The stressful whole environment could be more influential and harder to change.

It may be highly possible that depression will happen repeatedly if the surroundings remain unchanged. That is to say, a new environment may help abolish former established PITs and better reverse the cognition mechanism which leads to a possibility of environmental therapy. An environment of less pressure and more motivation may help build positive PIT towards environmental cues.

If future researches can find out where the negative effects of environmental cues come from, it may be possible to help the patient change their cognition and make them feel better about such cues. Since the cues themselves are not always directly related to the patient's passive behavior, it is possible that by changing their perception of the cues, they can generate positive feelings about the cues and stop the biased responses.

7. Instrumental behavior in safety learning and exposure therapy

Some patients may generate a feeling of fear and anxiety about specific things. It may be the established aversive PIT towards environmental cues that have left a harmful impression in one's mind. Such specific things as excitatory stimulus will give them a link with outcome representation such as soil referring to contamination—a symbol of fear. [5]

However, if the excitatory stimulus were removed, simply the outcome representation could make the patient less afraid of soil, instead, he may be afraid of swimming in the pool, since the fear of contamination is now stronger than the soil itself.

It finds out that, the way to ease fear may be using another safety stimulus to replace the original fear, and the instrumental response, such as avoidance, generates safety signals which inhibit anxiety. The therapy shows that the fear developed by bias could be eased by instrumental training.

Exposure therapy is effective because, by exposing patients to the excitatory stimulus and training them to successfully avoid it, they can generate conditioned inhibitors and ease their fear.

But the absence of excitatory stimulus is worth contemplating. To make sure the newly practiced safety learning could work, the replacement of the former PIT transfer is necessary, but the removal from fear of stimulus itself to an abstract conception doesn't mean the fear disappears. No one can remove the excitatory stimulus from training and simply establish abstract fear. The goal is not to cure the fear but to weaken the strength of fear towards a specific object.

It also inspires us to look into depression therapy: Is it possible to cover and replace the former negative Pavlovian cues? If a patient succeeds in positively assuming the environmental cues, can it help him/her resist the influence of depression? Will people grow up without undergoing strong negative experiences better at mental health?

8. Discussion

The instrumental behavior in depression development is the result of the human adaptation modulation system. Since instrumental behavior has been proven to influence depression, it is worth trying to keep it in depression therapy.

This paper has also discovered that the establishment of new and correct PIT could weaken the former behavior towards Pavlovian cues. Indicating that except for those direct medical treatments, therapies based on behavior training may be an effective but healthier method to treat depression in the long-term recovery, since they have no side effects and are easy to practice.

Apart from the instrumental behavior itself, environmental cues triggering instrumental behaviors are also a fundamental factor. The importance of the environment to depression development and

recovery can't be emphasized too much. The recovery from depression likely requires environmental progress. It can't be assumed that everyone is capable of taking on great pressure, but providing an easy environment for everyone is anything but easy. The way people change the future environment may emphasize positive education, building up a positive valence system towards the environment cues, while forming a cognition system of keeping a normal attitude towards unhappy experiences.

Recently, some specific environmental recovery facilities called "Green Pavilion Cottage" were established in China to help teenagers recover from depression and restart school. They intended to change the living environment of the stressful classroom in school and provide a more inclusive surrounding. Although they have a long way to go, it is a good try to change the current condition of the growing depressed population in modern society and the unbalanced development in therapy services.

It is worth thinking that the researches usually targeted at specific group of people. Given the fact that people's mental conditions change as time and environments change, maybe a further survey needs to be followed. For example, a survey investigating children from different family and school environments and their depression rate may reveal a difference in environmental cues and their role in depression development and recovery.

In the treatment of other psychological disorders, instrumental behavior is also used as a kind of effective method thanks to its changes in behavioral habits and cognitive changes.

However, there is still something to be improved. For future studies, it is necessary to connect research to clinical practices and add vibrational medical use factors. In this way, people could better compare different depression medicines from the perspective of instrumental behavior. Apart from the difference among the depression development, the PIT in different age groups and different stages of neuro-system development is also worth investigating.

9. Conclusion

This paper investigates the instrumental behavior and the PIT process in depression and other psychological disorders. It concludes the basic mechanism of PIT transfer. In the relation of instrumental behavior and MDD, an interactive mechanism could be seen between the PIT and the internal cognitive perception.

It compares the differences between appetitive and aversive PIT and their mechanism to suppress or accumulate depression. Both the block of the appetitive PIT and the enhanced aversive PIT could disrupt the normal circulation of action and mind.

Based on the "positive valence system", the mechanism of reward loss in anhedonia may be caused by a disruption in appetitive PIT. While in the aversive PIT, patients with depression are influenced by exaggerated negative environmental cues and develop a kind of biased cognitive mechanism.

In the aversive PIT, which has a more direct influence on depression, some chemical changes, like serotonin. The lack of serotonin disinhibits the punishment avoidance, directing to a depression-leading mechanism.

Emotion emotion-changing process is partly caused by such a mechanism, and it closely reflects the severity of depression.

In the end, safety learning and exposure therapy based on using newly established instrumental behavior to inhibit fear provides a specific application of instrumental behavior in therapy.

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