IB Extended Essay

Psychology

To what extent can classical conditioning and motor control systems serve as explanations to target panic?

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Abstract

Target panic is a psychological problem within archery that causes archers to experience a frustrating and seemingly inexplicable inability to hit the center of the target they are aiming at, due to involuntary movements and what is perceived by many as a loss of control over their technique. Many archers affected by target panic express frustration regarding their performance, and many have tried coming up with both causes and possible solutions to the problem.

However, the exact cause of the problem is not clear. Psychological research has led to two theories – classical conditioning and motor control systems – that could seemingly be related to the problem. To what extent can classical conditioning and motor control systems serve as explanations to target panic? Through investigating these two theories and their application to target panic symptoms, this essay attempts to answer this question.

The essay draws on findings from a range of studies in sports psychology, but primarily bases its research on the works of two authors – Kidwell and Turner. There is very little published material that directly relates to target panic, and while attempts have been made to diversify the references and citations in the text, some passages contain large amounts of information sourced only from a single author.

Both of the presented theories provide a scientifically valid explanation to target panic. Each of the theories are able to thoroughly describe the underlying causes of target panic, and produce concrete drills and exercises shown to have high rates of treatment efficiency. However, due to the lack of published research, and the large prevalence of target panic among archers, more research should be conducted to determine additional factors and to increase understanding and awareness of the problem. Research should also be conducted to find possible links to similar phenomena in other sports.

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Introducing target panic

Target panic is a psychological phenomenon within the field of sports psychology, which in the broadest sense, can be explained as "not being able to control the execution of the shot" when shooting arrows (Camera, 2010, Chapter 16, "Target panic", para. 1). This phenomenon affects a majority of archers (Turner, 2016, p. 1) and can be detrimental to their experience of the sport. Target panic can manifest itself in several different stages of the shooting process, and to better understand these manifestations, it is important to understand the process used to shoot a bow. This process can be described as a four-stage sequence (FITA Coaches Committee, 2003, Chapter 2).

The archery shot sequence

The first of these stages is *preparation* (FITA Coaches Committee, 2003, Chapter 2.1). The purpose of this stage is to bring the archer into the proper physical and psychological state before shooting the bow, and involves entering a proper and stable stance, nocking the arrow[1], gripping the bow and the bowstring, pre-positioning the body and raising the bow towards the target.

The second stage, *effort production*, involves movements related to drawing the bow to a fully-drawn position (FITA Coaches Committee, 2003, Chapter 2.2), such as drawing and aiming the bow and finding an anchor position for the drawing hand that, when reached, signifies that the archer is at full draw.

The third stage, or the *critical moment*, is the release of the arrow (FITA Coaches Committee, 2003, Chapter 2.3). Since the archer is essentially a "launching pad" for the arrow, the archer needs to ensure that there are no movements that may adversely affect the flight of the arrow. This means that the archer makes sure that he/she is completely still before releasing the arrow.

[1] Nocking an arrow means attaching the arrow to the bowstring so that it may be shot.

The fourth and final stage is *follow-through*. This can best be described as "the continuation of all the archer's activities during the effort production period; the physical ones, mental ones, visual ones, …." (FITA Coaches Committee, 2003, Chapter 2.4), and is important because even though the arrow has been released, it is still undergoing propulsion from the bowstring and is only completely out of the archer's ability to affect once it has completely cleared the bow. If the archer does not do proper follow-through, sudden movements on the archer's part before the arrow has cleared the bow may affect the movement of the arrow, sending it off course.

Manifestations of target panic

The symptoms of target panic primarily manifest themselves in three different ways: A premature anchor, premature release, or premature hold (Kidwell, 2016, paras. 3–5). These manifestations appear in the second and third stages outlined above. A premature anchor occurs when an archer fails to draw the bowstring all the way back to his/her normal anchor position. The archer may feel that a kind of barrier is encountered where the drawing process locks up in the middle of the draw, and that it is almost impossible to continue drawing in order to reach full draw. Kidwell (2016, para. 3) explains that this can happen "at any position before the shooter gets to a full anchor position," and that it "most often occurs close to the anchor point," but that he has seen archers stop drawing just halfway towards that point.

The second manifestation of target panic, premature release, occurs when the archer "involuntarily releases an arrow at some point before an anchor is reached or aiming can take place" (Kidwell, 2016, para. 4). Archers experiencing this type of target panic may have significant problems in avoiding letting the arrow be shot too early, with the release process starting more or less automatically at some point before an anchor position is reached. As Kidwell aptly puts it, "at some point in the process the arrow will be GONE!" This type of target panic is often frustrating to archers because of the lack of control that characterizes it (Kidwell, 2016, para. 4). Premature release is sometimes further divided into three subcategories: Short drawing (releasing before anchor is reached) and snap shooting (releasing without a consistent

anchor and shoulder alignment), and releasing immediately upon target acquisition (Camera, 2010, Chapter 16, "Target panic", para. 2).

The third form, premature hold, is a scenario in which the archer is able to reach full draw, but demonstrates a significant difficulty of aiming, specifically that they cannot bring their arrow (point of aim) onto the center of the target (Kidwell, 2016, para. 5). Kidwell explains that archers experiencing premature hold, in an attempt to compensate for the off-center aiming, often try to push towards the bullseye at the time of release. This will result in a harsh release and unwanted movement in the release stage of the shooting process. There are also mentions of collapse and inability to release the arrow as target panic symptoms, respectively described as "loss of back tension prior to or during the release" and the inability to "let the fingers relax enough to allow the string to escape cleanly" (Camera, 2010, Chapter 16, "Target panic", para. 2).

Similar phenomena in other sports

Target panic itself is a topic that has received very little academic attention, and few, if any, studies have been performed on the topic. As such, it might be useful to look into other precision sports to see if similar phenomena may be identified and linked to archery. One such sport is golf.

Golfing

In golf, there is a phenomenon known as the *yips*, which consists of "involuntary movements appearing shortly before hitting the ball that results in loss of control and usually missing the putt" (Klämpfl, Lobinger, & Raab, 2013, p. 1271). While it is not the exact same phenomenon as target panic, it is similar, and one can describe target panic in a similar means in that the movements appear shortly before releasing the arrow, often resulting in missing the intended target. The yips itself is a multi-aetiological phenomenon, the cause of which is thought to be somewhere between focal dystonia and choking under pressure (Smith et al., 2003). These types of yips were classified as *type-I* and *type-II* yips. Smith et al. found that golfers who experienced yips differed on several variables including "age of acquisition, documentation of EEG activity to

date, strokes affected and the treatment interventions likely to be successful" depending on which of these classifications applied to each golfer. And while several studies show that anxiety affects the severity of the yips (Sachdev, 1992; Smith et al., 2000), it is not in itself an anxiety disorder (Sachdev, 1992). Given the similarities between yips and target panic, the possibility that performance anxiety is connected to target panic in some way should not be ignored.

Trapshooting

Trapshooters may also be affected by a similar phenomenon. Trapshooters who have been practicing their sport for a long time, typically around ten years, start complaining that "the index finger refuses to move or is seized with a cramp" and that "occasionally, a shooter states that it feels as though his finger has run into some invisible 'force field' and is immobilized" (Ajax, 1982, p. 131). Ajax explains that this type of motor affliction starts manifesting itself after years of repeated execution of the same muscular activity, and is only apparent when the affected muscles are performing this particular activity. While gunsmiths are coming up with release triggers that try and alleviate the problems, and a range of explanations have been presented to try and pinpoint possible causes, the exact etiology of the problem is, at the time of writing of this article, not known (Ajax, 1982, p. 131). These symptoms are also present in target panic to some extent, in particular the "inability to release the arrow" observed as a possible symptom of target panic (Camera, 2010, Chapter 16, "Target panic", para. 2).

Possible causes of target panic

Due to the frustrating nature of target panic, archers and coaches affected by or having extensive experience with target panic tend to try and come up with possible explanations and solutions that they can utilize to understand and treat its symptoms. However, many of these explanations are based on common sense and interpretation, and do not take a scientific research approach. This leads to the discovery of potential causal factors that "appear to make sense on the surface," but that are actually incorrect when looked at from a more scientific perspective (Kidwell, 2004, Chapter 7, para. 4). Kidwell introduces us to four of these factors (Kidwell, 2016, paras. 9–12). The first one, being a factor that many are likely to suggest, is "fear of failure, fear of success or

lack of confidence" (Camera, 2010, Chapter 16, "Target panic", paras. 3–4). While a lack of confidence is likely to result from target panic, Kidwell points out that this sets in only *after* target panic symptoms set in, and that neither fear of failure, fear of success nor lack of confidence are causal factors behind the phenomenon. Experiments with hypnosis have also been shown to be ineffective in the treatment of target panic (Kidwell, 2016, para. 9), suggesting that the phenomenon is largely unrelated to this factor.

The second factor is bad form. An archer having bad form implies that he/she has an inconsistent, improper or disadvantageous technique. Naturally, the symptoms of target panic themselves are definitive signs of bad form, though explaining it in this way implies that this bad form itself is the cause of target panic. Kidwell notes that "accomplished shooters with impeccable form appear to be more susceptible to develop target panic symptoms" and that "shooters with poor form or inconsistent form appear to be almost immune to the problem" (Kidwell, 2016, para. 10).

The third factor, faulty concentration, is also similar to bad form in that increased awareness of it apparently increases the vulnerability of the archer in developing target panic (Kidwell, 2016, para. 11). Based on this, one can conclude on a possibility that increased awareness of one's technique can somehow increase the risk of developing target panic. This will be further discussed in the following sections.

The fourth factor is shooting a bow that is too heavy (Kidwell, 2016, para. 12), which is often connected to physical difficulties drawing the bow, unsteady anchoring, rapid fatigue and loss of accuracy (Camera, 2010, Chapter 4, para. 10). Kidwell notes that shooting a bow that is too heavy might contribute to target panic, though the target panic symptoms tend to be caused by excessive weight. This indicates that the problem would not be reproducible with a lower weight bow if that was the case. This factor, known as being "over-bowed," does not cause target panic by itself (Kidwell, 2004, Chapter 7, para. 4).

In the previous section, it has already been concluded that there might be a link between the yips and other phenomena and target panic in archery, but there are also some explanations

available that address target panic directly. One of these is the *theory of conditioned reflexes*, or *classical conditioning*. This theory suggests that an individual can be trained in such a way that a conditional stimulus, that does not normally elicit a particular response with the individual, can be paired with an unconditional stimulus (that always leads to this response), in such a way that the conditional stimulus will also elicit the same response (conditional response) when it is later introduced in absence of the unconditional stimulus (Pavlov, 1927). Pavlov demonstrated this using dogs in his study by producing a whistle immediately before feeding the dogs meat powder. The production of meat powder by Pavlov initiated a salivation response with the dogs. After enough repetitions of this procedure, this salivation response could be invoked by producing the whistle *without* the meat powder being present (Kidwell, 2004, Chapter 7, paras. 6–7). In this case, the meat powder was the unconditional stimulus that, when paired with the conditional stimulus (the whistle), also caused the conditional stimulus to elicit the same type of response by the dog. Some research suggests that the classical conditioning demonstrated by Pavlov may be the underlying reason for the acquisition of target panic (Kidwell, 2004, Chapter 7).

Target panic as a form of classical conditioning

Classical conditioning is able to explain several of the target panic symptoms, and to better understand this link, it might be useful to again look at similar phenomena from other sports; in particular, gun shooting. Shooters who shoot magnum handguns have a tendency to develop what is known as a "flinch" – that is, jerking the gun just as they pull the trigger, causing an alteration in the direction their gun is pointing such that the shooter misses their intended target. If one were to place dummy loads in the gun instead of real ammunition, without the shooter being aware that this is done, it would be observed that the shooter will keep flinching despite the gun not actually firing (Kidwell, 2004, Chapter 7, para. 11, 2016, para. 28). It has also been shown, as opposed to pulling the trigger quickly, that by very slowly increasing the force exerted against the trigger by the shooter's finger, so that the shooter cannot anticipate when the gun will actually fire, the shooter is less likely to flinch during the trigger; hence they are less

likely to cause unwanted movement to the gun at the moment the shot is fired (Saul & Hirsch, 1954, p. 266).

By designating the steps of the gun shooting sequence as unconditioned stimuli (henceforth "US"), conditioned stimuli (henceforth "CS") and response (the natural response to US, henceforth "R"), Kidwell (2004, Chapter 7, para. 11, 2016, para. 28) explains flinching in terms of classical conditioning. The recoil that the shooter experiences when shooting the gun is always caused by the ignition and firing of the bullet inside the barrel. From this, Kidwell deduces that the ignition of the cartridge is the unconditioned stimuli that always causes the response of recoil. Because the ignition of the cartridge is always immediately preceded by pulling the trigger, a pairing is eventually formed between pulling the trigger and recoil, conditioning the shooter to learn that pulling the trigger (CS) always causes recoil (R). This explains why affected shooters also flinch when there is no active firing load in the chamber – the shooter learns that triggering the gun will cause recoil, so they brace themselves for this response (Kidwell, 2004, Chapter 7, para. 11).

Target panic can be described in a very similar way. Looking at the shooting process, we can see that an archer first nocks their arrow, raises their bow, draws the bowstring backwards to acquire full draw, anchors, acquires the bullseye, then releases the arrow (FITA Coaches Committee, 2003, Chapter 2). Depending on what target panic symptom the archer experiences, this process may be slightly different or simplified. If the symptom is a premature release, then the process is drawing (CS), followed by anchoring (US) and finally releasing the arrow (R). Through many repetitions, it is learned that the draw always precedes the anchor, which in turn always precedes the release. Hence, an association is formed between drawing (CS) and releasing the arrow (R), and the process starts skipping directly from the conditioned stimuli to the response (Kidwell, 2016, para. 31), likewise to what was discovered in Pavlov's (1927) study.

Similarly, if the archer struggles with a premature anchor, one can describe the shooting process as initiating the draw (CS), completing the draw (US) and anchoring (R). Over time, the association that is formed is that initiating the draw (CS) will always lead to anchoring (R),

hence the archer anchors before full draw has actually been reached (Kidwell, 2016, para. 32). The process that would ensure full draw is the unconditioned response, which is now skipped with the new association.

Finally, there is the symptom of a premature hold. Premature hold involves aiming, and the responsible process starts with moving the point of aim towards the bullseye (CS), is followed by acquiring the bullseye (US) and ends with holding the aim at the bullseye (R) before releasing. Since moving the point of aim towards the bullseye always causes the bullseye to be acquired as the aiming point, and this in turn makes the archer slow down their movements and hold the aim still, an association is formed between motion towards the bullseye (CS) and ceasing movements and entering a hold (R) (Kidwell, 2004, Chapter 7, para. 16, 2016, para. 34). This causes the archer to anticipate and enter a hold before acquisition of the bullseye has been performed, rendering the archer incapable of the final movement towards the actual bullseye acquisition.

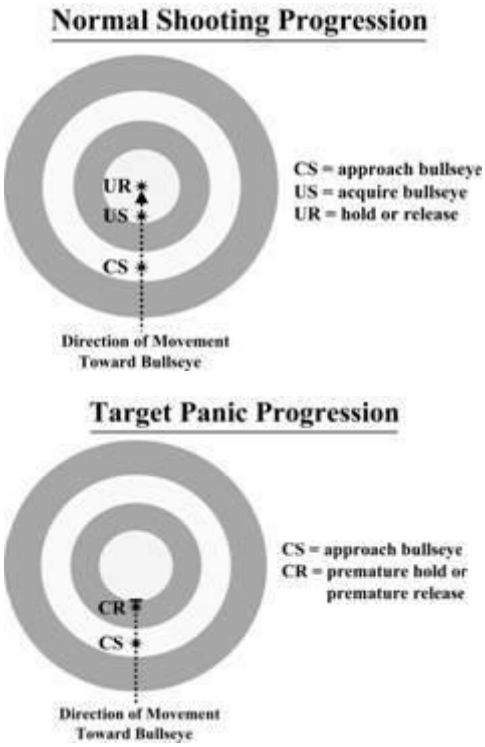

Figure 1 - Premature hold explained in terms of classical conditioning (Kidwell, 2004)

Several interventions for target panic based on the theory of classical conditioning have proven to be extremely effective when applied correctly (Kidwell, 2016, para. 35). Kidwell specifically mentions three drills that apply the principles of classical conditioning and systematic desensitization, which has been proven to effective for counterconditioning (Davidson, 1968), to help archers get rid of target panic. The *sliding anchor drill*, designed to counter premature release and anchor, involves the archer "[drawing] one-half inch past anchor then [sliding] back to [their] real anchor position" (Kidwell, 2016, para. 36), which tells the subconscious that the anchor point is no longer predicable, and as such, should not be

anticipated. Hence, the conditioning that the subconscious has learned through repetitive training, and that causes target panic, is countered because it is no longer valid. The same is true for the "move through drill" that counters premature hold. The move through drill involves drawing a figure 8 with the point of aim at full draw "where the intersection of the 8 crosses through the bullseye" before letting down and relaxing (Kidwell, 2016, para. 37). According to Kidwell, this teaches the subconscious that the bullseye of the target, where movement would ordinarily stop, is no longer predicable and should not be anticipated by stopping prematurely. Kidwell (2016, para. 35) reports a success rate of up to 100% in curing target panic using these interventions.

Motor control system explanation of target panic

While classical conditioning is one way to explain target panic, some have attempted to come up with other science-based explanations. One of the most notable of these alternatives is the *theory of open-/closed-loop control systems*, or *motor control systems*. This theory proposes that a motor sequence can either be an open-loop or closed-loop system. An *open-loop system* implies a defined input and output and that when invoked, does not have any means of error regulation or feedback (Adams, 1971, p. 116). The system has an executive (the brain) and an effector (the muscles performing the requested action), where the executive transmits a motor program to the effector for execution (Turner, 2016, p. 6). The *closed-loop system* does, as opposed to the open-loop system, offer "feedback, error detection, and error correction as key elements" (Adams, 1971, p. 116), and allows its movements to be stopped or changed during execution (Turner, 2016, pp. 8–9).

To understand the application of this theory to target panic, we need to look at what is described as the core problem of shooting – that is, "the mind will not allow you to cause your body impact as a surprise. If the mind knows an explosion is imminent, it will formulate a response to that explosion" (Turner, 2016, p. 1). Turner explains this as a natural self-preservation response. This can also help explain why some other sports, such as basketball, are not affected by target panic-like symptoms. While effect of a bow firing an arrow can be

explained as an explosion due to the recoil involved, explaining basketball in the same way is difficult. The mind initiates a self-preservation response against the explosion of the bow because it perceives it as a threat. However, in basketball, the goal is throwing a ball, and as Turner notes, "there is no self-preservation response connected to throwing anything" (2016, p. 3). If the ball *did* actually explode, Turner explains the outcome would likely have been different, with the thrower bracing for the explosion and thereby altering the direction of the throw.

In archery, the *goal* is to create and ignore such an explosion. As Turner states, "your mind does not and will never see that as a good thing" (2016, p. 3). The archer's mind does not want to be unprepared for such an explosion. Therefore, it will time the release so that the archer can brace themselves before it happens. The mind thinks that it would be much more efficient to only draw the bow partially before releasing, so that it knows when the explosion will take place (Turner, 2016, p. 4). This would explain premature release. Similarly, premature hold may, according to Turner, be explained by the mind knowing that when the aim is placed on the bullseye, the explosive release happens. Therefore, it will not allow the archer to aim at the bullseye. Due to the repetitive nature of shooting, the motor sequence used to perform a shot becomes more and more automated and ingrained in the mind. And with each target panic-affected shot, the self-preservation response of the mind becomes stronger. Eventually, target panic starts to become a real problem – typically starting around the two-year mark of an archer's career (Turner, 2016, p. 5).

Turner explains target panic as being an example of an open loop control system. The mind will attempt to perform the automatic bow shooting sequence in such a way that it "can be efficient at bracing" (Turner, 2016, pp. 7–8). Turner proposes the alternative of a closed-loop control system in order for archers to retain full control over their shot. The closed-loop system is very similar to the open-loop system in that it has an executive and an effector, which represent the brain and the muscles, respectively, though it also has a comparator, whose task it is "[to receive] feedback from the body" and is "where the movement is evaluated for errors"

(Turner, 2016, p. 9). Turner explains that by having a shot slow enough that errors in the shot process can be detected, the bad shot can be stopped before it is executed.

There are several steps an archer can use to get themselves into a closed-loop shooting process. One of these is the use of attentional cues or mantras (Turner, 2016, pp. 14–16, 24). By using a mantra that directs attention to a certain group of muscles, it becomes easier to "encourage" those muscles to do work. Turner notes that while any mantras may be used, it is preferred to use something that refers to the desired motion, e.g. "keep pulling, keep pulling, keep pulling" to focus consciously on the action of pulling the bowstring further backwards. This should also be paired with a psychological trigger of some sort that acts as the "GO" signal for releasing the arrow, and that trigger has to be non-anticipatory (Turner, 2016, pp. 20–21). By being non-anticipatory, the mind cannot predict when the explosion of the bow will happen, and it will be unable to brace the body for the impact that that entails. As such, triggers like a clicker[2], which Kidwell (2016, paras. 15–16) also mentions, work because the mind has no way of anticipating the click of the clicker, however, a trigger that involves e.g. counting to three and releasing on the "e" sound of "three", will not work because counting is a pattern that is anticipatory and the mind will "know when the trigger is coming" (Turner, 2016, p. 21). The importance of letting down a shot without firing it is also highlighted when the archer detects a possible error in the closed-loop system when shooting, so that the error may be corrected before the shot is executed (Turner, 2016, pp. 26–27, 39).

Conclusion

To what extent can classical conditioning and motor control systems serve as explanations to target panic? By investigating these theories, it is possible to establish strong links to target panic that may serve as qualitative explanations relating to causal factors behind the problem, and effective interventions for the symptoms can be derived that are based on research in these fields

[2] A device which indicates to the archer, through means of an audible click, that they are at full draw (Kidwell, 2016, paras. 15–16; Turner, 2016, p. 22)

of psychology. Similar phenomena are also found in other sports that may offer alternative explanations of the issue. However, sports psychology is a relatively new field of psychology, and despite the level of knowledge provided by researchers of target panic, in particular Kidwell and Turner, little is known about the phenomenon. Many interpretations of target panic are based on common sense rather than scientific research, and virtually no studies have been done on the topic.

Future research should evaluate the theories presented above, and explore the extent to which explanations of target panic can also explain similar phenomena in other sports and vice versa.

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