Developing imagery ability in esport athletes using layered stimulus response training

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Review

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Abstract: For esport athletes to effectively use imagery and experience its many benefits, they must develop a collection of skills referred to as imagery ability. Layered stimulus response training (LSRT) is an evidence-based technique informed by bioinformational theory to improve how easily someone can form rich and vivid images that more closely approximate the real-life situation. In turn, having a better ability to generate and control clear and vivid images is associated with better performance and optimal mental and emotional states. The aim of this paper is to explain how sport psychologists can guide esport athletes through cycles of LSRT, which involves imaging, evaluating, reflecting, and then developing images in progressive layers of different stimulus, response, and meaning propositions. Aids to image generation and other variations of LSRT as well as future research opportunities for applying LSRT to esport are also discussed.

Keywords: bioinformational theory; controllability; image generation; progressive imagery; vividness.

Esports (electronic sports) are a rapidly developing competitive field that draws many parallels with sport and has an audience of 474 million people around the world (LEVVVEL, 2022). Esport athletes participate in organized and regulated competitions in specifically designed video games such as real time strategy (RTS) games, multiplayer online battle arenas (MOBAs), first-person shooter (FPS), as well as games based on traditional forms of sport such as football or motorsport (Pereira et al., 2022). There is a large and growing participation base of both casual players and professional esport athletes who dedicate themselves to many hours of training and competing (Poulus et al., 2022). It is fiercely competitive at the top levels with professional esport athletes competing for vast sums of prize money (Wechsler et al., 2021), with the total prize pool for a single tournament reaching as high as USD$48 million (i.e., Dota 2) in 2021 (Esports Earnings, 2021). Esports has also taken a step towards being included in mainstream sport mega-events with its inclusion as a pilot event at the 2022 Commonwealth Games in Birmingham UK (Chahal & Pandey, 2022).

Esport athletes need well developed mental skills, such as imagery, to meet the many cognitive, psychological, and physical demands associated with their type of game (Himmelstein et al., 2017; Nagorsky & Wiemeyer, 2020). In particular, esport competitors experience unique stressors (e.g., in-game pressure) which predict symptoms of anxiety and depression (Smith et al., 2022). It is already well established that using imagery in frequent, deliberate, and systematic ways is a characteristic of expert performance in sport and imagery is effective for enhancing learning and performance (Cumming & Hall, 2002; Simonsmeier et al., 2021) and enhancing an athlete's well-being (Kouali et al., 2020). Imagery can also be used to bolster self-confidence (Callow & Waters, 2005), respond more effectively to stress in competition (Quinton et al., 2019), and support athletes to recover from injury (Multhaupt & Beuth, 2018). But for esport athletes to realize these benefits, they must have an ability to form, control, and retain vivid images of sights, sounds, feelings, and sensations (Morris et al., 2005). In other words, imagery ability is a collection of skills for esport athletes to develop that involves multiple processes (e.g., image generation and maintenance) and multiple senses (e.g., visual, auditory, kinesthetic, and haptic) (Cumming & Eaves, 2018). There is growing evidence that better imagery ability in athletes is associated with better performance and optimal mental and emotional states such as higher levels of confidence, lower levels of cognitive anxiety, and viewing situations as a challenge rather than a threat (Quinton et al., 2019; Williams & Cumming, 2015; Williams et al., 2021).

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A person's imagery ability is partly determined by genetics but is also influenced by the amount and quality of practice (Cumming & Eaves, 2018). While imagery ability can be somewhat improved by just using imagery, an even more effective way is through layered stimulus response training (LSRT), or more simply put, developing images in layers (Cumming et al., 2017; Weibull et al., 2017; Williams et al., 2013). LSRT is typically guided by a sport psychologist and helps athletes to experience rich and vivid images that more closely approximate the real-life situation by adding different elements of the image in progressive layers. Based on Lang's bioinformational theory (Lang, 1977, 1979), any image can be separated into units of stimulus, response, or meaning information that are stored in long-term memory (see Table 1 for definitions and examples). Each piece of information represents a different element that can be incorporated into creating a highly meaningful and detailed representation of a desired image, which in turn, can be used as an "as-if real" template that can supplement or substitute for actual practice (Ji et al., 2016). Taking a personalized approach, LSRT begins with a simple version of this desired image with most details removed and a focus on creating a specific layer of information. Other relevant pieces of information are gradually introduced until the desired image can be vividly generated and controlled with ease by the person. In doing so, LSRT is proposed to not only enable athletes to generate and maintain desired images (e.g., imaging our self or our team achieving a personal best score or winning the game), but also to eliminate or control undesired images (e.g., imaging our self or our team making a mistake or failing to achieve an important goal) (Cumming et al., 2017).

How to use LSRT

Breaking down an image into different elements and bringing them together in increasingly detailed layers is achieved through cycles of imaging, evaluating, reflecting, and developing the next imagery layer (Figure 1). An esport athlete might start LSRT by identifying a common situation that occurs during gameplay that they can easily recall from

Table 1: Definitions and examples of layered stimulus response training (LSRT) elements.

Element	Definition	Examples
Stimulus information	Sensory-based perceptions of an external or internal stimulus[a]	Sights Smells Sounds Pain Temperature changes
Response information	Behavioral, physiological, and linguistic changes in response to the stimulus	Activity level changes (e.g., withdrawing/avoiding) Heart rate and respiration changes Muscles relaxing/tensing Self-talk
Meaning information	Semantic and nonsemantic information of what the individual's response to the stimulus means	Self-perceptions (e.g., confidence, mental toughness) Stress appraisals (e.g., challenge, threat)

[a]A stimulus can be anything (e.g., object or event) that triggers a response in the person.

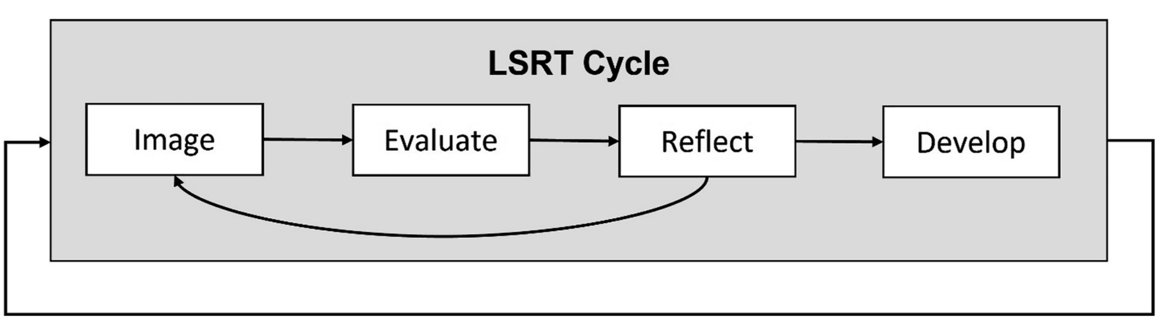

Figure 1: Layered stimulus response training (LSRT) cycle. This is an updated version of Cumming et al.'s (2017) description of LSRT to include evaluate as the second step in the cycle.

Table 2: Layered stimulus response training (LSRT) process example in esports (rocket league).

Layer	Game examples
Situation described	Intercepting the ball to stop a goal in rocket league
1: Visual features	Own and others car details (colour, model, speed, location, personalization)
	Pitch and wider arena
	Ball (colour, speed, location relative to car)
	Scoreboard, time
2: Audio of game sounds	Own and others car engines
	Encouragement from teammates
	Boost from own or others' cars
	A nearby crash or explosion
	Indicator of time left (e.g., 10 s countdown)
3: Kinesthetic features	Sensations of making quick, repetitive movement of fingers, hands, and wrists
	Feel of console/mouse, headset, and position of body in the chair
4: Cognitive and physiological features	Meeting attentional demands of staying focused on the ball and ignoring distractions (e.g., other cars)
	Physiological responses (e.g., increased heart rate and breathing rate, feeling warm)
5: Optimal emotions and meaning propositions	Staying calm and confident, knowing that the angle and speed is correct to reach the goal in time
	Appraisal of situation as a challenge, not a threat
	Release of any tension in body real time

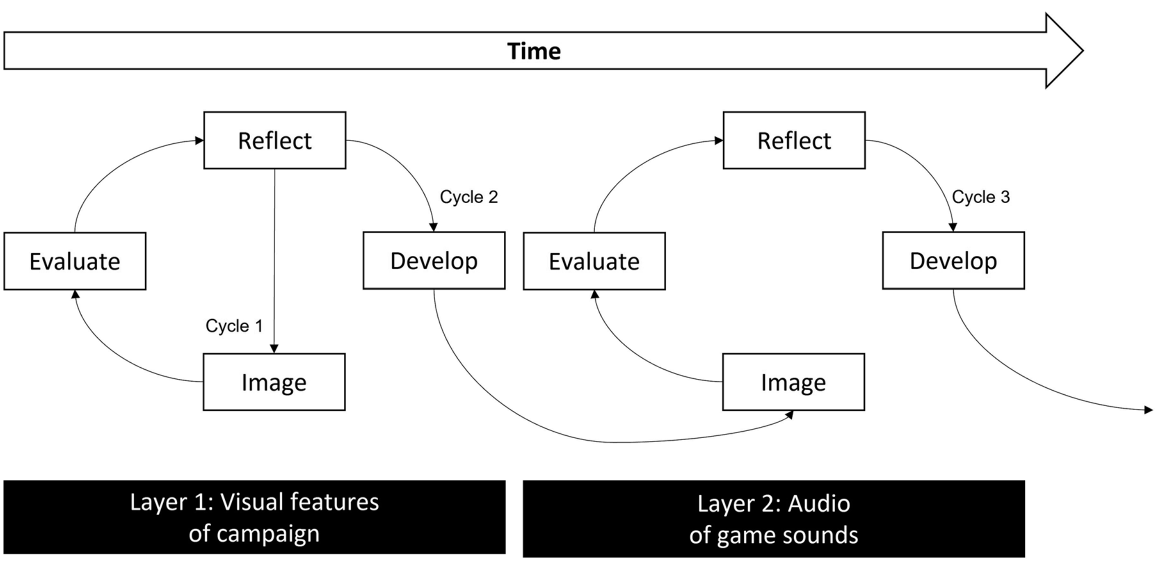

Figure 2: Example application of LSRT to esport athlete. In this example, the athlete remains with the first layer (i.e., visual features of the campaign) for two LSRT cycles, and then does one LSRT cycle of the second layer (i.e., audio of game sounds) before progressing to layer 3.

memory. Take for example, Casey, who would like to focus on intercepting the ball to stop a goal in Rocket League (see Table 2 and Figure 2). The sport psychologist asks Casey to verbally describe this situation in as much detail as possible, before instructing him to image the situation as vividly and clearly as possible as if he were actually performing the action and with his eyes closed (Cooley et al., 2013). Casey is then asked to evaluate properties of the image using a Likert-type rating scale, such as its vividness and clarity (1=*no image at all, only thinking of the situation*; 5=*a perfectly clear and vivid image*), its ease of generation (1=*very hard to image*; 5=*very easy to image*), and its controllability (1=*highly uncontrollable*, 5=*highly controllable*). These values provide indicators of Casey's imagery ability that can be used to make comparisons against as more layers are added as well as serve as immediate feedback to inform Casey's reflections in the next part of the cycle (Cumming et al., 2017).

The sport psychologist then guides Casey to reflect on the content (e.g., “What did you see?”, “What did you feel?”) and characteristics (e.g., “Did you see the image through a first person or third person perspective?”) of the image (for more a detailed description of imagery characteristics, see Cumming & Williams, 2012). For an esport athlete with poor imagery ability or little experience in using imagery, it is not unusual for them to find it difficult to provide a detailed description of the imagery experience in the early stages of LSRT, particularly if the image is hazy and unclear. The focus is to instead identify an element of the image that the athlete finds particularly easy or vivid to generate based on the evaluation stage. In this example, Casey would like to focus on visual aspects of the game (e.g., the colors and design features of his car and the ball). Casey will then re-image the situation with a focus on making this visual image as clear and as vivid as possible (layer 1), re-evaluate its vividness/ease/controllability, and reflect again on its content and characteristics. During this second reflection, the sport psychologist listens for any new details described by Casey (e.g., colors are brighter, features are more detailed) and provides feedback on Casey’s imagery ratings (e.g., improved, stayed the same, or worsened). Unless the ratings have improved, Casey may wish to continue rehearsing this layer until he finds it easier to generate and control a clear and vivid image.

When ready to progress, the sport psychologist will ask Casey to identify the next element to add to the image (layer 2). This is usually the element that the athlete finds the next easiest to image, such as another sensory modality. To keep with the same example, Casey might identify the game’s sounds (auditory) as the next layer to develop such as the sounds of his own and other car’s engines. Casey would then image the situation again with a focus on this new element, which is then evaluated and reflected on. This process continues of either re-imaging the same layer or developing subsequent layers by adding stimulus, response, and meaning information that Casey identifies as the next most relevant and important. Examples of what else could be included are kinesthetic sensations of making quick, repetitive movement of fingers, hands, and wrists, meeting attentional demands of staying focused on key aspects of the game and ignoring distractions, and experiencing optimal emotions such as staying calm and confident in knowing what to do in the situation (Table 2).

As the content of the imaged situation evolves, so may the characteristics of the Casey’s imagery use (Cumming et al., 2017); for example, if the image was previously experienced in slow motion, it may now be done in real time or if the image was viewed in a third person perspective (external visual imagery; i.e., seeing the image from the perspective of being removed from one’s body, as if watching oneself on video), it may now be seen through a first person perspective (internal visual imagery; i.e., seeing the image through one’s own eyes, as if experiencing the situation in real life). Encouraging the esport athlete to reflect on how they image during cycles of LSRT will also help them to develop their meta-imagery skills; that is improving their awareness, knowledge, and control of their own imagery processes and preferences (Moran, 2009). These meta-imagery skills enable esport athletes to use imagery more effectively, such as by selecting content and employing characteristics to suit them, the situation, and their reasons for imaging (e.g., to perform more successfully under the pressure of competing) (Cumming & Williams, 2013).

After several layers, Casey may reach a point where he can no longer identify relevant stimulus, response, or meaning information to include in the image. This final image could be considered completely developed and Casey could use this image as the bases for further mental practice. In the case of an endurance cyclist described by Cumming et al. (2017), the cyclist experienced a number of benefits to carrying on rehearsing the final image including improvements to their focus and being in better control of thoughts, feelings, and physiological responses, which led to improved performance. An important caveat, however, is Casey should regularly revisit and update the image to ensure that it is still relevant and meaningful, for example, after learning and improvement takes place in the real life context (Holmes & Collins, 2001). LSRT can then be used to develop other desired images as a way for esport athletes to continually improve and refine their ability to form, control, and retain images in their mind.

Variations of LSRT

LSRT is a flexible technique that can be used in conjunction with other techniques to meet the esport athlete’s needs, particularly for those who find it very difficult to form images. Similar to the approach used by Quinton et al. (2014), the sport psychologist could be guided by the PETTLEP model (Holmes & Collins, 2001; Scott et al., 2022) and ask the esport athlete to perform LSRT in the location where they usually play the game, sitting in their gamer chair, and wearing their headset. To help generate tactile or kinesthetic elements of the image, they may find it helpful to position their fingers and wrists using their keyboard and mouse as well as perform small movements during the imagery. The game soundtrack and audio recordings of other relevant sounds could be played to support auditory elements being incorporated into the image. Similarly, visual elements could be made easier to form with observation (Scott et al., 2022), which would involve the esport athlete viewing a video of either themselves and/or recorded/live streaming of someone else performing prior to imaging. Research has previously shown that people find it significantly easier to see a movement in their imagery after watching a video of it being performed, particularly if the video is filmed using the same viewpoint adopted by the imager (Williams et al., 2011). Put another way, a video showing the movement from a first person perspective will more effectively support the athlete's visual imagery if the athlete then images the movement from this perspective rather than a third person perspective. Williams et al. (2011) also found that observing a movement made it easier for participants to feel that movement in their imagery regardless of the viewpoint shown in the video. These different aids to image generation can be individually applied when needed to the layer being developed or used in combination with each other as the image becomes more detailed and complex. The aids can also be sequentially removed when the athlete is able to easily generate and control a clear and vivid image.

Research has also started to look at other variations of LSRT, such as by comparing a simplified and de-personalized version referred to as progressive imagery to retrogressive imagery (Chien et al., 2022; Fazel et al., 2018, 2022). In this research, participants are given an imagery script that describes the content to be imaged over a number of sessions. In the progressive imagery condition, the initial script describes a simple scene and details are added in sequence until a detailed and complex image is fully described in the final script. The process is reversed in the retrogressive imagery, with the initial script describing the detailed and complex scene and details are then gradually removed. For both these approaches, the content of the script and what details are added/removed are determined by the researchers. In addition to depersonalizing the process, these approaches do not provide participants with an opportunity to verbally reflect on their imagery experience or include stimulus, response, and meaning propositions. By omitting core elements of LSRT, it is unclear whether these approaches will be as effective for improving imagery ability and meta-imagery skills in those who find it harder to image. But, there is some initial evidence that progressive and retrogressive imagery may be useful interventions for athletes already sufficiently skilled in using imagery and who are aiming to improve their performance, self-confidence/self-efficacy, and reduce state anxiety levels (Chien et al., 2022; Fazel et al., 2018, 2022).

Future research opportunities

Although research has shown LSRT to be an effective technique, both alone (Williams et al., 2013) and in combination with observation (Marshall & Wright, 2016), there are a number of potential avenues to investigate in the future. Researchers could first determine the effectiveness of LSRT for developing imagery ability in e-sport such as by replicating and extending Williams et al. (2013)'s study in this context. Williams et al. recruited novice golfers who had never previously received imagery training and reported low ability to form complex sport images. Compared to the motor imagery (i.e., "imagine yourself correctly and successfully performing the golf putting task") and visual imagery (i.e., "imagine seeing the golf ball run along the green and gently roll into the hole") practice groups, only participants in the LSRT practice group who developed their images in layers improved both their ability to image movement and golf putting performance. A similar paradigm could be used in esport athletes low in both experience and imagery ability to compare LSRT to imagery control conditions that are closely matched in terms of frequency, duration, and content of the imagery. Performance metrics would depend on the chosen esport under investigation, but it would be useful to include indicators that are predictive of successful performance; for example, in the case of FPS game Counter-Strike: Global Offensive, response time, reaction time, and mouse and keyboard proficiency can be used to assess a player's performance (Sharpe et al., 2022).

A second avenue of future research would be to investigate for who and under which conditions would it be suitable to recommend LSRT or simplified variations. Given that skill level moderates imagery use (Cumming & Hall, 2002), research could compare LSRT with progressive and/or retrogressive imagery for lower and higher skilled players. According to Lang (1977), images that contain response information will be more vivid and more likely to lead to behavioural change in the real-life context. In support, Smith et al., (2001) found that imagery scripts that included both types of information led to greater improvements in hockey penalty flick performance than stimulus only scripts. Moreover, imagery scripts that included participant-generated stimulus and response propositions led to higher imagery ability ratings than experimenter-generated imagery scripts (Wilson et al., 2010). Based on this evidence, we would expect that LSRT to outperform progressive and retrogressive imagery, regardless of skill level, given its personalized approach and inclusion of stimulus, response, and meaning information. But the benefits may be even greater for lower skilled esport athletes who have the most potential for improvement.

Studies have mainly examined the effects of delivering LSRT to individuals but this technique can also be used with pairs and groups (Cumming et al., 2017; Quinton et al., 2014). Whether it is casual players voluntarily forming groups or professional esport teams recruited to play on a contract, team dynamics and communication has been identified as a potential barrier for achieving optimal esport performance (Himmelstein et al., 2017). Team cohesion and collective efficacy are both positively associated with imagery use (Curtin et al., 2016; Shearer et al., 2007), and given that higher imagery ability is associated with greater imagery use, it follows that imagery will be even more beneficial for enhancing team dynamics if esport athletes find it easier to image their team (e.g., "I imagine the team being mentally tough"). For MOBA games such as League of Legends, LSRT could be used as team building experience by having teams of 5 players collectively identify the situation to be imaged, sharing reflections with each other, as well as deciding together on what layers to add. Research could then be used to investigate the effectiveness of team-level LSRT on individual imagery ability, team-level perceptions (e.g., team cohesion, collective efficacy), and performance indicators (e.g., the number of towers and inhibitors taken; Novak et al., 2020).

Another novel area for future LSRT research could be in its application specifically with younger esports athletes. This direction of research is especially pertinent for esports where it is reported that the youngest professional is 16 years old, with retirement age speculated to be around 25 years (Mamerow, 2022). Imagery ability has been shown to improve in children aged 8–10 years (Taktek et al., 2008), but scarce research has applied LSRT to youth sport contexts. One exception is Quinton et al. (2014) who delivered a 5-week PETTLEP imagery intervention to groups of young futsal players (*M* age=9.72 years). To adapt the intervention to children, PETTLEP elements and associated propositions were gradually introduced in a layered approach, starting with easier elements (e.g., Physical as they were stood in their kit) and progressing to more difficult elements (e.g., Emotion, such as feeling confident). Participants reported finding internal (first person perspective) visual and external (third person perspective) visual imagery easier to image than kinesthetic imagery, which is supported by research indicating children start to use kinesthetic imagery when older (13–14 years) (Munroe-Chandler et al., 2007). When adapting LSRT to young esport athletes, it may therefore be beneficial to incorporate kinesthetic imagery in later layers once visual imagery ability is established. Furthermore, future research would benefit from comparing imagery ability and LSRT's effectiveness in younger vs. older children (Quinton et al., 2014).

Conclusions

LSRT is a personalized and theoretically-grounded technique for improving imagery ability in progressive layers of stimulus, response, and meaning information. Evidence of its effectiveness in sport populations suggests that esport athletes may also benefit from its use, particularly those who find it difficult to form and control clear, vivid, and lifelike images.

LSRT is also flexible so that it can be adapted by a sport psychologist to meet the specific needs of the individual or team. Research is now needed to examine the effects of implementing LSRT in different types of esports with athletes of varying skill levels and imagery ability.

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