# Power Development and Motor Learning

## *Teaching the Snatch from an Information Processing Perspective*

Rory O'Brien, MS, CSCS, PES
Guardian Strength and Conditioning

## Introduction

The snatch is one of two lifts performed in the sport of Olympic Weightlifting, though is also used in performance training programs (Schutts et al., 2017). Athletes from sports which require elite levels of power, such as rugby, basketball, track & field, and American football, utilize this and other Olympic Weightlifting derivatives to assist in speed and power development. However, operators in tactical occupations can also benefit greatly from speed and power development, as success in tactical operations depends largely upon physical attributes such as anaerobic power (Mala et al., 2015; Maupin et al., 2018). Olympic lifts such as the snatch can be utilized by tactical athletes to assist in the development of anaerobic power and speed.

The snatch is a barbell exercise which consists of 5 main phases: the first pull, transition phase, second phase, turnover phase, and catch (Gourgoulis et al., 2009; Schutts et al., 2017). Clearly, this exercise, like other Olympic lifting variations, is highly technical, and for this reason, it is essential that athletes learn the snatch from a qualified coach who is aware of motor learning theory and its implementation. Motor learning refers to the learning, performance of, and improvement on, movement skills. Specifically within the discipline of motor learning is the Information Processing Model, which describes how people process information to learn, remember, and perform motor skills in the short and long-term. An exploration of teaching the snatch from this perspective, in light of recent research on the snatch and coaching methods, may provide coaches a framework with which to teach and improve snatch technique in a manner which is both efficient and which maximizes the often limited performance training time available for tactical units.

## Situational Overview

For the purposes of this exploration, a hypothetical tactical athlete will be the subject being taught the snatch. This tactical athlete, an American special operator, has recently been discharged from physical therapy and cleared for full strength and conditioning training after suffering a combat injury to his right leg. However, he has missed the Olympic weightlifting lessons that the rest of his unit received while still in physical therapy and not yet cleared for full training. He has requested to work with the unit's strength and conditioning coach in order to formally learn the Olympic lifts. As a special operator with previous experience as a top-level high school athlete, he has a wide array of athletic abilities and has used the Olympic lifts in an informal capacity in the past, yet has not learned them directly from a qualified coach. He is a motivated athlete and is eager to return to full fitness and explosiveness after his injury.

After demonstrating mastery in the kettlebell swing and proficiency in hinging movements, as well as having been cleared for highly explosive lifts by the physical therapy team, he is ready to begin the Olympic lifts. He will be training in his unit's weight room in the base performance training center, which is fully equipped with lifting platforms, barbells, and bumper plates. The coaching staff is also able to utilize cameras with kinematic tracking software to assist in assessing form and technique. As a highly motivated athlete, the subject is able to mentally engage himself in the training session, and this anticipation is augmented by an intentionally developed dynamic warm-up. He is able to reach high levels of arousal due to his motivation and mental engagement in the learning process.

## Classifying the Snatch as a Motor Skill

Within the discipline of motor learning, movements are classified into three main groupings: the amount of musculature utilized in the movement (gross motor skill vs. fine motor skill); the specificity of the movement's beginning and end (task organization - discrete, serial, or continuous); and the relative stability of the environment (closed skill vs. open skill). The snatch is a gross motor skill due to the fact that it utilizes a large amount of musculature; in the case of the snatch, it is a compound full-body exercise. As a single exercise, the snatch could be considered a discrete movement as, when performed correctly, it is one fluid motion; there is a clear beginning and end to the exercise as a whole, with no pauses. In contrast, the clean and jerk (the other primary Olympic lift), could be considered a serial movement as it is in actuality two motions strung together - a clean (hinge) is performed before pausing, followed then by the jerk (overhead press). Lastly, the snatch is a closed skill, meaning that the environment in which it is performed is predictable with little to no stability demands other than those imposed by the action of moving the barbell. Since the floor is flat, this creates a highly stable surface upon which to perform the movement.

## Literature Review

As an advanced, technical exercise that carries a high injury risk if performed without correct technique, it is essential that the snatch be taught by a qualified individual who understands both the biomechanics of the lift as well as sound teaching methods. Attention to recent research and teaching methods of the Olympic lifts is a fruitful component of professional development for a strength and conditioning specialist who works with strength and power athletes such as tactical operators. As an in-depth biomechanical analysis of the snatch is out of the purview of this paper, this brief literature review will focus primarily upon methods of teaching the snatch in light of motor learning principles such as information processing, attention, and athlete feedback.

The primary peer-reviewed article for this paper comes from Schutts et al. (2017), wherein the researchers studied how an athlete's focus of attention (FOA) impacted kinematic performance measures in the snatch. Recent literature from motor control research has demonstrated that externally-focused verbal instructions enhance performance better than do internally-focused verbal instructions in a variety of motor skills. By definition, an externally-focused verbal attention turns an athlete's attentional focus toward the movement outcome, rather than inward toward one's own movement. The externally-focused verbal instruction utilized by the researchers in this study was for participants to "*concentrate on moving the barbell back and up rapidly*", whereas the internally-focused verbal instruction was for participants to "*concentrate on moving your elbows high and to the side rapidly*". Based upon these different instructions - both intended to elicit the same outcome - it is apparent that an external FOA turns the subject's attentional focus to the movement outcome, and an internal FOA turns attention to the movement of the body. Based upon their initial research, Schutts and colleagues hypothesized that externally-focused verbal instructions would prove more beneficial to performance outcomes than would internally-focused ones.

To carry out this study, Schutts and colleagues gathered 12 participants, all competitively-trained athletes, who were split into two groups. The groups performed the snatch exercise after being given either externally-focused or internally-focused coaching cues (as stated in full above). The primary kinematic measures that were taken by the researchers were: peak instantaneous barbell velocity (Peak BarVV), peak instantaneous horizontal barbell velocity (Peak BarHV), and peak instantaneous vertical elbow velocity (Peak ElbowVV). Along with these measures, a subsequent measure was taken, namely the barbell-cervical-hip angle (BCH). This angle, according to the researchers, is “an evaluative measure to see where a potential technical flaw occurred in the lift” (Schutts et al., 2017). The smaller this angle is, the less likely it is that a flaw has occurred in the lift. The results of the study demonstrated that external FOA improved lifting performance in all kinematic measures, including BCH, therefore supporting the researchers’ hypothesis.

In discussing the results in light of previous research that supports the use of external FOA strategies in place of internal FOA strategies, the researchers concluded that for the snatch in particular, external FOA strategies are superior to internal ones. In part, they point out, this can be explained by Wulf’s constrained action hypothesis, which states that overly focusing on a movement itself (as would be the case in an internal FOA strategy), interrupts reflexive autonomic control processes. As the snatch is highly dependent on these reflexive processes (being an explosive lift), it is reasonable to connect internal FOA strategies to possible lower kinematic performance measures in the snatch. According to the researchers, barbell velocity measures were superior in the external FOA group versus the internal FOA group, which supports the connection between their findings and Wulf’s hypothesis.

Schutts and colleagues concluded that the success of a lift can depend highly on an athlete’s focus of attention, as there were two times more unsuccessful lifts using internal FOA than external. Also discussed by the researchers was the overall importance of coaches thinking critically about how they develop verbal instructions. Clearly, based upon their findings and conclusions, external FOA strategies are highly recommended by the research team. They point out that external FOA strategies will “allow the lifter to free attentional resources through the use of fast, reflexive autonomic control processes” (Schutts et al., 2017). Recommended for future research is an investigation into electromyographic activation differences between external and internal FOA strategies.

As seen above, motor learning principles such as attention, coaching cues, and an athlete’s understanding of movements plays a large role in teaching a technical motor skill such as the snatch. The study carried out by Schutts et al., however, is not the only study on the snatch from a motor learning perspective. Souissi et al. (2021) investigated motor learning and the snatch via distance during the COVID-19 lockdowns. All participants (minus the control group) were given the opportunity to see video feedback of their own previous lifts in order to self-correct their technique. One group, however, was given the opportunity to further learn and self-reflect on snatch technique through being provided with pedagogical supplements to assist with error detection and the feedback provision process. The other group only was able to watch their own video feedback. The researchers concluded that the inclusion of pedagogical feedback can help improve motor learning of the snatch. Though this study was carried out via distance motor learning, there are still a number of lessons learned from it which can be applied to in-person motor learning techniques when teaching the snatch, which will be explored below.

In another study, Soussi et al. (2020) investigated different methods of instruction in the snatch to discover which would elicit the greatest benefits of motor skill development in the snatch. With groups split between a self-observation method with direct instructions group (SO-DI), a self-observation alone group (SO), or a direct instruction group (DI), the researchers measured kinematic parameters of the snatch. The results were very similar to their distance motor learning study noted above, with the SO-DI group having superior kinematic measures than the other two groups. Milanese et al. (2016) also investigated motor learning methods in the snatch lift and found that athletes who were given the opportunity to self-identify errors – similarly to the video feedback approach utilized by Soussi et al. (2021) – improved several kinematic parameters more than did athletes who were only given direct instruction. All of these studies highlight the importance of a thorough understanding of motor learning strategies when teaching the snatch, highlighted by Milanese and colleagues' conclusion that while practice is essential for improving learning, "*the efficacy of the learning process is essential in enhancing learners' motivation and sport enjoyment*" (2016). As motivation and attitude are both essential components of motor skill learning, they are indeed important areas of focus in research and the coaching of highly technical movements such as the snatch.

## **Information Processing and the Snatch**

The Information Processing Model describes how people process information to learn, remember, and perform motor skills in the short and long-term. There are several components of this model of motor learning, namely: sensory input and display, the sensory register, the selective filter, encoding, short-term memory, and choice delay. This section will explore the hypothetical tactical athlete (introduced previously) learning the snatch from an information processing perspective. Each component of the Information Processing Model will help to illuminate motor learning of the snatch.

The first component of the Information Processing Model is the display (or sensory input). This includes any and all environmental input, weather, coaching cues, proprioceptive feedback, and overall noise and possible distractions that could impact the learner. In the present scenario, the athlete is learning the snatch indoors in a temperature controlled weight room, meaning that weather will not be a distraction or mode of input. Music that his teammates are listening to pose a possible distraction to the athlete, while the different workouts that they are performing do so as well. Due to the snatch being a very closed motor skill, proprioceptive input is limited only to the strict movement demands of the exercise (ie. there is no unstable surface or pushing opponents to contend with). The coach shows the learner a video of a perfectly executed snatch from the Olympics due to the work of Soussi et al. (2021) which demonstrates the usefulness of this strategy, along with video of the athlete's own technique during each rest period. However, the learner does hear coaching cues and feel his own body moving in tandem with the barbell. The coach utilizes external focus of attention strategies due to the work of Schutts et al. (2017), which demonstrates the benefits of this approach. For this reason, the coach uses the phrase from the above study as his primary coaching cue: "*concentrate on moving the barbell back and up rapidly*." For this reason the athlete is highly tuned in to the achievement of the outcome of the lift, rather than only his own body movements.

Within information processing theory, there are three major components of memory (Kortschak Center, 2015). The first is known as the sensory register, or sensory store. The capacity for this first memory type is very large, but the duration very short (visual input remains for only a second or less, while auditory input can last for up to 3 seconds). As explained above, input that enters the sensory register can come from an array of sources – proprioceptive, auditory cues from a coach, visual, neurovestibular, etc. Most of this input, even if recognized by the brain, is not moved into short-term (or working) memory. As a highly motivated athlete with the attention to detail that is required of special operators, the learner is able to sift through whether display input is useful or not. The process of retaining certain informational input and forgetting unnecessary information is known as the selective filter. Input such as loud music and the distraction of his teammates is filtered out, as this is not helpful to the learning of a technical motor skill. Instead, he focuses on coaching cues directing him to focus on the outcome of the lift, giving a high level of attention to his coach's verbal instructions. If adequate attention is given to the task at hand and certain input registered by the brain, the input can be moved into working memory, a type of short-term memory which lasts for up to 30 seconds.

In order to retain this information in working memory, the athlete must pay attention to and assign value to it. The process of retaining this information and storing it in working memory is called encoding. Encoding information into working memory is the first step toward true motor learning (which consists of the motor skill being saved in long-term memory and being able to be recalled and performed at a later time). The specific pieces of information that will be encoded by the learner into short-term memory are the image of the Olympic athlete performing the snatch from the video as well as his own previous lifts. He will also encode the coach's verbal cues and his own comparison of his technique to the Olympian's.

Unlike the sensory register, however, working memory has a very small capacity for information, only able to hold between 5 and 9 pieces of information at a time. Though it may seem helpful to only be able to retain such a small amount of information, it is necessary – and beneficial in the long run – to only focus on a limited amount of information at a time due to the high level of attention that is required for true learning to take place. In order to assist the learner in moving the information highlighted above into working memory, strategies will be utilized during rest periods such as video feedback with pedagogical cues (see Soussi et al., 2021) and opportunity for self-detection and correction of errors (see Milanese et al., 2017).

Long-term memory, like the sensory register, has a very large capacity for information, but as the name implies, this information can be retained indefinitely, provided adequate opportunities for recall and practice. To store information in long-term memory, it is necessary to encode the information and make sense of it in association with other information that is already known. When moving information from short-term (working) memory to long-term memory, a delay occurs called choice delay. This refers to a delay of understanding, interpretation, and execution that can hamper one's ability to truly learn a motor skill and store it in long-term memory. In other words, this reflects the quality of learning that takes place. When a motor skill (in this case the snatch) is committed to long-term memory, it is essential for the skill to be practiced regularly. When the skill is attended to and performed, this is referred to as response execution. The information which is stored for the movement can be moved back and forth between long-term and short-term memory when practiced, allowing for reinforcement of previous learning to occur which will in turn provide an opportunity for the athlete to improve upon the skill. In order to truly improve, however, motor learning principles such as attention, motivation, and focus are still highly necessary.

## Conclusion

The snatch is a highly technical lift which requires not only physical attributes such as explosiveness, mobility, and coordination (Sandau et al., 2021), but also mental qualities such as attention to detail, motivation, openness to learn, and focus (Schutts et al., 2017). As a discrete, closed motor skill, it is able to be learned in controlled indoor environments and can be monitored by cameras and kinematic tracking software to assist in the learning and assessment process. Indeed, strategies employing these tools have been used to both assist in teaching (Soussi et al., 2021) and evaluating(Liu et al., 2022; Sandau et al., 2021; Hadi et al., 2012; Ho et al., 2014) the snatch. Due to demonstrated efficacy in a number of studies, strategies such as external focus-of-attention cues, video monitoring, and self-correction of errors are recommended for coaches and athletes learning and seeking to improve upon the snatch. For tactical athletes, who often have limited training time, these methods of learning the snatch could prove a beneficial route to essential power development, as the snatch can provide adaptations favoring high levels of explosiveness in a short period of time.

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