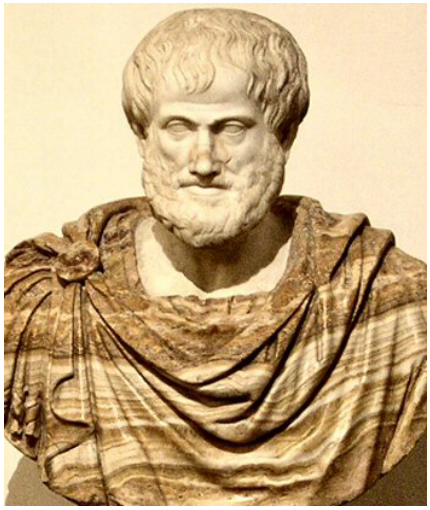
Specificity Part 4: Types of Specificity



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Abstract

Specificity can be fractionated into several discrete categories. These include Sensory Specificity, Context Specificity, Pattern Specificity, Rate Specificity, Resistance Specificity, and Processing Specificity. The purpose of this article was to review each of these categories.

Introduction

The previous articles discussed the theoretical rationale for Henry's (1958) Specificity of Learning hypothesis. Thorndike's and Woodworth's (1901) Identical Elements of Transfer Theory suggested that the transfer of training from one task to another would occur proportionally to the amount of shared elements between tasks. Hull's (1943, 1952) theory would suggest that the elements were performance variables such as the lighting in the environment, and internal states such as arousal of an organism. Therefore practicing in one environment could predict performance in another environment proportionally to the similarity of conditions. Guthrie (1950, 1952) suggested that these elements were numerous bonds between environmental and internal stimuli which could initiate the desired response. These bonds represented the acquisition of skill, and were specific to the situation they were acquired in. Therefore, Guthrie (1950, 1952) suggested that learning was specific to each situation, and that the learner should therefore practice in as similar a situation as possible to the desired criterion goal. Finally the most current and dominant theory for Specificity was provided by Henry (1958). He suggested that

each Motor Task required a large collection of underlying attributes, which supported the task. By changing the task participants would change the underlying attributes supporting that task. As with previous theories, transfer of training occurred only in so much as the underlying attributes of the task were similar. In this context, the purpose of this paper was to identify the broad variables which determine the similarity of the elements, bonds, or attributes which underlie any two tasks. These variables or types of specificity include Sensory Specificity, Context Specificity, Pattern Specificity, Rate Specificity, Resistance Specificity, and Processing Specificity.

Sensory Specificity

Work by Adams (1971) led Proteau (1992) to propose the Specificity of Practice Hypothesis, which suggests 'that learning must be specific to the sources of afferent feedback used to guide one's movement during practice (Trembley and Proteau, 1998).' In greater detail Proteau (2001) posits that ' learning appears to be specific to the sources of afferent information used to ensure optimal accuracy during practice; and when that information is withdrawn in a transfer test, performance suffers because the individual has no reliable source of reference with which to evaluate his or her movement.' In this context ' learning involves a sensorimotor representation that integrates the motor components with the sensory information available during practice (Schmidt and Lee, 1999).' Therefore performance on transfer will be proportional to the similarity of those conditions to that of the practice conditions.

In this context Proteau, Marteniuk, Girouard, and Dugas (1987) investigated the effect of increased practice on the reliance on visual information. They had participants practice an aiming movement for 200 or 2,000 trials under either a full-vision condition or a condition in which they could see only the target to be reached (target-only condition). After acquisition, both the visual and target only conditions performed under target only conditions. It was found that notably greater errors in performance were found in the condition that originally performed with vision. However, what was most interesting was that the error was greater in the 2,000 trial condition than the 200 trial condition. This suggests that as practice continues, participants become more and more reliant on the sensorimotor representation.

Even more intriguing was a study by Proteau, Marteniuk, and Levesque (1992). They examined the effect of adding vision to a group, which had practiced under target only conditions. Results indicated that the addition of vision actually degraded performance! This also provides evidence that Specificity increases as a function of practice.

It is therefore critical to consider that there are numerous afferent sources of feedback that are provided by internal and external environments. The source, which allows the participant to succeed optimally, will have the greatest influence on the sensorimotor representation created. Trembley and Proteau (1998) has refined his hypothesis further to state that learning is specific to the source(s) of afferent information which permit(s) one to obtain optimal performance during practice (See, Proteau, 1992 for a full review of supporting evidence). This has several practical implications. For example, investigations which study elite athletes' use of afferent information can determine which source of information best determines an optimal outcome for those elites. This information could be utilized to accelerate participants

along the learning curve at a much more rapid rate by causing them to focus immediately on that information.

Context (Environmental) Specificity

Context Specificity is a concept, which suggests that transfer from one environment to a second environment in the execution of a criterion task will be proportional to the similarity of the cues between the two environments. To clarify, Wright and Shea (1991) state that there are two broad forms of stimuli within the Context of a situation. The first are known as Intentional stimuli and are defined as stimuli essential for achieving the criterion task. The second, denoted incidental stimuli are defined as stimuli not directly associated with completion of the task, but that have the potential to become associated with specific tasks due to their selective presence in the learning environment. An example of intentional stimuli may be the sight of a moving target in a tracking task, where as incidental stimuli could be background noise such as music, temperature, or fragrance.

Context Specificity falls underneath Guthrie's (1952) theory of learning discussed previously. Guthrie (1952) proposed that a behavior was triggered by specific incidental stimuli. Hergenhan and Olsen (2005) summarize by stating that 'Guthrie's advice is always to practice the exact behaviors that are going to be demanded of us; in addition we should practice them in the exact conditions under which we are going to be tested or evaluated. If we want to utilize this information beyond the testing situation, we must go beyond the classroom and associate other stimuli with the behavior that the book or class or lecture caused us to do.' Therefore learning is not only a matter of practicing the task, it is also a matter of forming bonds or associations between that behavior and incidental stimuli. Guthrie (1942) summarizes by suggesting that 'we learn what we do in the presence of specific stimuli.'

Voeks (1950) who studied under Guthrie's theory developed four postulates based on its predictions. Postulate 1 is known as the Principle of Association and states that ' Any stimulus pattern that once accompanies a response…becomes a full strength direct cue for that response. This is the only way in which stimulus patterns not now cues for a particular response can become direct cues for that response.' In postulate III, the Principle of Response Probability, she states that ' The probability of any particular response occurring at some specified time is a function of the proportion of the stimuli present which are at the time cues for that response (Voeks, 1950).'

To investigate the effect of incidental stimuli on skill acquisition, Wright and Shea (1991) had participants work on learning specific patterns of key pressing movements on a computer. Incidental stimuli in the form of audio were provided for each specific pattern. After practicing, participants were allowed to rest. When tested again they were examined with either the same auditory stimuli, or different stimuli. It was found that performance in retention was greatest when the same auditory stimuli were present, suggesting that the stimuli served as learned or associated cues to trigger the desired response.

This may explain the home advantage, which has been investigated in sport contests for over 20 years (Bray et al., 2002). Bray et al. (2002) suggests that results have consistently demonstrated that there tends to be a performance advantage

associated with competing at home among major professional and collegiate leagues. While a number of factors have been identified such as the crowd, travel, and rule factors that could favor the home team (Courneya & Carron, 1992), as well as confidence associated with a home environment and anxiety on the road (Bray and Widmeyer, 2000; Jurkovac ,1985, Duffy and Hinwood, 1997), the influence of outside stimuli remains an important factor
(Courneya and Carron, 1992, Schmidt and Lee, 1999). For example, the confidence seen at home, may be attributed to past experiences supported by environmental cues. According to Voeks (1950) when playing at home the probability of performing a given response increases, which would therefore tend to result in a greater number of wins. According to Bandera (1997), situation specific self confidence (self efficacy) will rise with positive experiences.

Pattern Specificity

Sawyer (2005) posits that the motor program contains the spatial and temporal elements within an individual, that when initiated allows for the expression of complex movement behavior. In this context, the spatial elements represent the pattern, or geometric aspects of a particular movement sequence. Two outcomes can occur through adjustment of movement patterns. First, the pattern can be adjusted such that an entirely new program is needed. Secondly, if the adjustments are subtle enough, and practiced for a long enough time, modification of the program's spatial elements can occur. In a review on transfer of training, Uebel (1987) suggests that when choosing exercises other then the criterion task the participant must be careful with movements that are similar, but not identical to the task, as they may have a negative transfer effect.

An example of this can be found in added resistance paradigms. Lockie et al. (2003) investigated the effects of sled towing on acceleration sprint kinematics in field-sport athletes. Twenty men completed a series of sprints without resistance and with loads equating to 12.6 and 32.2% of body mass. It was found that Stride length was significantly reduced by approximately 10 and approximately 24% for each load. Stride frequency also decreased. In addition, sled towing increased ground contact time, trunk lean, and hip flexion. Upper-body results showed an increase in shoulder range of motion with added resistance. Paradisis (2001) investigated the effect of a 3-degree incline on sprint kinematics. It was found that there were significant changes in posture on the touchdown and takeoff. Further, stride length decreased by 5.2 %, which was associated with changes in posture along with reduced flight distance. The authors summarize the results as follows: 'Given the interaction between the acute changes in step length and posture when sprinting on a sloping surface, our findings suggest that such changes in posture will detract from the specificity of training on such surfaces. ' Far worse however is the danger of negatively changing the movement pattern. Therefore, any form of practice should be extremely cautious when tampering with the geometry of the movement.

Resistance Specificity

In terms of weight training performance within a specific criterion lift, there appears to be a repetition continuum in which specific adaptations occur. In a review by Fleck and Kraemer (2004) it was found that generally 1-6 repetitions had the greatest effect on 1 repetition maximum performance, 8-12 repetitions had the greatest effect on muscular hypertrophy, while above this range had the greatest

effect on the ability to perform the exercise at high repetitions while withstanding fatigue effects. Therefore resistance utilized in weight training will have specific adaptations.

A second form of resistance training is to add the resistance to a specific sport task, such as running. As discussed, this can have negative effects on the pattern of movement. Therefore it is suggested that if resistance is used, that it is done cautiously, in such a manner that the pattern is not significantly altered. This may be done by adding very low resistance. For example Derane (1985, 1990, and 1993) found in three studies that baseball throwing velocity increased for both slightly lighter and heavier balls. . There are several theoretical rationales for this. The first, would fall under the law of accommodation, which suggests that the response of a biological object to a given stimulus decreases over time, necessitating the need for variation. If that variation can be provided, without degrading the motor program then adaptations may occur. Derenne et al. (1993) suggests that highly specific fast movements could recruit and fire high-threshold fast muscle fibers to a greater extent. Fast twitch motor units have a greater capacity to assist in high velocity movements. Therefore n selective activation of fast motor units in muscle could be specifically trained.

The issue on added resistance is again changing the pattern of movement, as was discussed previously. The change in pattern could be due to too great a load added. However, it can also occur through misplacement of the resistance. For example, ankle weights primarily provide vertical resistance to the runner, when the runner is traveling in a horizontal manner.

Rate / Velocity Specificity

Rate or Velocity Specificity is a concept revealed through studies which suggests that performance increases occur to their greatest extent at the velocity they are practiced at
(Fleck et al., 2004). Further, while significant gains do occur in performance other than the criterion velocity, they generally increase with velocities that are closer to the criterion velocity.

Further, if the velocity is changed drastically enough it may actually alter the order and magnitude of muscular action (Wilson, 2003)

Contractile Specificity

Contractile Specificity suggests that the greatest increases in performance will come as a result of the types of contractions utilized in practice. For example, Schott et al. (1995) investigated the transfer between isometric knee extension increases in performance and an increase in several isokinetic movement velocities. It was found that the results produced typically no significant increases in isokinetic strength, suggesting that the best way to increase isometric performance is to train isometrically, and the best way to increase isokinetic performance is to train isokinetically.

Joint-Angle Specificity

Joint angle Specificity suggests that performance increases take place primarily at the criterion angle, and the transfer from one angle to another is proportional to the proximity of the angles trained. For example, Knapik et al. (1983) found that training the elbow flexors at 90 degrees results in increased isometric strength at 90 degrees, with only very small increases up to 20 degrees away from the specific angle.

Processing Specificity

There is an old adage which suggests that ' perfect practice makes perfect.' The individual(s) who proposed this adage first were clearly ignorant of Processing Specificity, which suggests that the transfer between two conditions will be proportional to the similarity of the underlying processes which occur between those two conditions. A key researcher of processing Specificity is Dr. McCullah of California State Hayward University. She is considered by many as the world's leading authority on modeling, and has served as President of the Association for the Advancement of Applied Sport Psychology and most recently the North American Society for the Psychology of Sport and Physical Activity. She has also served on the editorial boards of the top Exercise Journals in the world, including Research Quarterly for Exercise and Sport. Of key importance was a study by McCullah and Card (1990), who investigated the effect of a learning model with Knowledge of Results (KR) vs. a correct model with KR on performance in a timing task. They also examined the effects of a learning model who did not receive knowledge of results. Modeling has been proposed to produce a symbolic representation of the models performance in a perceptual trace or reference of correctness (Sheffield, 1961). In this context, the participant will continually compare his or her performance against the perceptual trace until it is correct, suggesting that a correct model would appear to provide the greatest learning, as it would provide a perfect reference of correctness. However, McCullah and Card (1990) found that observation of a learning model provided greater performance in retention than the correct model! The theoretical rationale is Processing Specificity. Lee and White (1990) suggest that two of the processes which occur in motor learning are error-detection and correction in problem solving activities. The correct model does not display either error detection or problem solving activities. However, the learning model with knowledge of results provides the learner with an opportunity to view the model both encounter errors, and make corrections to problems encountered (Pollock and Lee, 1992) . Therefore the learner not only produces a reference of correctness, but develops error detection mechanisms. McCullagh and Card (1990) also provided KR to the model, so that the model would know if they made an error or not. According to Adams (1986) this further enhances learning as it both assists in forming the reference of correctness and allows the observer to participate in the cognitive activities of the learning process. This was confirmed in the McCullagh and Card study who found that the learning model without knowledge of results had worse performance than the other conditions.

Many practice conditions can be explained by processing specificity. An example is found in Random vs. Blocked Practice. In Random Practice, the participant never performs a task consecutively, where as in blocked practice they perform the task in a consecutive order. In practice performance is worse in the Random condition than blocked. However, after a period of rest, it is found that Random practice produces better learning! This is due to underlying process optimization in the Random

practice condition, and is discussed in depth in the article entitled conditions of practice.

Summary

Five categories of specificity were discussed. Sensory Specificity suggests that afferent feedback is integrated with motor elements to form a sensorimotor representation of the task. In this context, the closer the sensory information from one situation to another, the greater the transfer will be. Context Specificity suggests that the transfer between performing a task in two environments will be proportional to the similarity of those environments. This is thought to be due to associations made between the task and incidental stimuli. Pattern Specificity refers to the geometric representation of a task. Individuals should be careful not to change the geometric elements of the program, through mechanisms such as sled towing in running. Resistance provided in the task will elicit specific adaptations to that task. Rate Specificity suggests that practice should attempt to mimick the velocity utilized in a competition setting. Finally processing Specificity suggests that practice will transfer to criterion in so much as the underlying processes governing the criterion task are utilized during practice.

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