Sound Body, Sound Mind, and Successful Performance: Exploring Movement and Artistic Expression in Gymnastics, Dance, Martial Arts, Music, and Beyond from an Embodied Cognition Perspective

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Abstract

Embodied cognition, a more recent approach to understanding how human beings think, emphasizes relationships between cognition and physical action. A key assumption of embodied cognition is that our physical/bodily interactions with the environment allow us to more advantageously perceive, remember, contemplate, and act on complex information that is presented to us. This paper specifically explores embodied cognition in the context of athletic preparation for competition and achievement during competition under the assumption that the impressive capabilities and performances that athletes and musical performers are able to achieve can be investigated and more comprehensively understood through an embodied cognition perspective. Athletic activities such as gymnastics, dance, and the martial arts (for example, Aikido) will be investigated, and similar performative characteristics and influences in music will be explored. The paper will discuss the historical underpinnings and evolutionary elements of embodied cognition, the fundamental attributes of embodiment, comparisons between more traditional cognitivist and computational approaches to cognition, and the application of embodied cognition to athletic and musical performances. In addition, the paper will examine the strange phenomenon of "choking under pressure," how prior experience influences judging ability as it relates to gymnastics, the impact of an athlete's self-concept and self-belief based on support offered by coaches and their peers, and various coping skills utilized by athletes in preparation for competition.

Introduction

The embodied cognition approach to understanding human thought is characterized by an agent's firsthand recognition of and interaction with an environment that is somewhat familiar to the agent. This recognition and the subsequent information that the agent takes away from the engagement with the environment is considered to occur without cognitive or advanced perceptual processing, in which acquired heuristics, propositional contents, and encoded algorithms that have been stored in the mind are not utilized (Cappuccio, 2015). Questions that can be asked when considering the scope of investigation concerning embodied cognition include, for example: "What can voices do? What can fingers do? What can bodily rhythms do? What can sensitive listening do? What can unison movement do? What can storytelling and role-playing do? What can precise skeletal alignment do? What can intensive daily training do? What can aerobic exercise do? What can relaxation and meditation do?" (Spatz, 2017, p. 5). This approach contrasts with the more traditional cognitive perspectives, which assume that intelligent operations require logical processing in some form, particularly via various forms of rudimentary symbolic manipulation that extract amodal information from the external environment without contextual influence (Cappuccio, 2015).

A variety of theorists have supported the embodied cognition perspective, relating it to numerous contexts that describe how the mind works. For instance, Paul M. Fitts and Michael I. Posner's cognitive-computational approach (1967) emphasizes how more than just "intellectual" mental processes are required for the body to effectively perceive, remember, think, and act; such activity is only fully made possible with the body's interaction with the external environment (Cappuccio, 2015). Further, James Gibson's cognitive-ecological approach (1979) describes how the body aids in much of the information-processing phenomena that many have associated with internal activity of the mind in classical approaches to understanding cognition (Cappuccio, 2015). Gibson also developed a theory of affordances, in which he defines affordances as "the offers, consistent in opportunities of interaction, that the objects present in the environment possess in relation to the sensorimotor capacities of different animals: 'The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill'' ([*The Ecological Approach to Visual Perception*,] p. 127)" (Garbarini & Adenzato, 2004, p. 100). As such, objects that are present in the external environment provide a variety of affordances for human beings and other animals, depending on their current needs, although these affordances are an intrinsic feature of the object, and not formulated by the needs or intentions of the viewer (Garbarini & Adenzato, 2004). Other influential theorists in the embodied cognition perspective that will be examined in this paper include George Lakoff and Mark Johnson, Eleanor Rosch, Daniel Dennett, Maurice Merleau-Ponty, and William T. Powers.

This paper seeks to explore embodied cognition as it relates to preparation prior to competition and achievement during competition in an attempt to show that the impressive capabilities and performances that athletes and musical performers are able to achieve can be investigated and more comprehensively understood through an embodied cognition perspective. Key elements and assumptions of embodied cognition will be examined in the contexts of athletics, such as artistic and rhythmic gymnastics, dance, and the martial arts (specifically, Aikido) and in music. The paper will investigate the history of the development of embodied cognition as an approach to understanding human cognitive abilities (Aizawa, 2015; Garbarini & Adenzato, 2004; Dennett, 1996; Illundáin-Agurruza, 2013; Raab & Araújo, 2019; Robinson, 2007; Spatz, 2017) and its evolutionary support (Wilson, 2008), comparisons between more traditional cognitivist and computational approaches to cognition, and the application of embodied cognition to athletic performance (Allen-Collinson, 2009; Barrero González, 2019; Bradshaw, 2010; Cappuccio, 2015; Chirazi, 2021; Kimmel & Rogler, 2018; Luis del Campo & Espada Gracia, 2018; Pizzera, 2012; Snowber, 2012) and musical performance (Cox, 2016; Schiavio, Gesbert, Reybrouck, Hauw, & Parncutt, 2019) . Finally, the paper will examine the odd phenomenon of “choking under pressure,” how prior experience influences judging ability as it relates to gymnastics, the impact of an athlete’s self-concept and self-belief based on support offered by coaches and their peers, and various coping skills utilized by athletes in preparation for competition.

Embodied Cognition from an Evolutionary Perspective

In considering embodied cognition as a result of the evolutionary process, human beings fundamentally developed cognitive abilities from the structure of the physical human body, causing the brain to develop and evolve in response to the body’s actions and existing needs over time. Rather than considering cognition as strictly a direct result of the body’s immediate physical environment, the embodied cognition perspective, particularly when recognizing its evolutionary underpinnings, also encompasses the mind’s ability to produce more abstract, de-contextualized thoughts, which resulted from these sensorimotor abilities that existed prior (Wilson, 2008). Upon further examination of the evolutionary process from which human beings developed, the numerous cognitive abilities that are shared by humans can be traced back approximately 8 million years. Human beings evolved from the hominids, which refer to the family of primate mammals, or the great apes, first from gorillas roughly 8 million years ago, and second from chimpanzees and bonobos roughly 6 million years ago. Humans began to emerge from their ancestors in an ecologically different environment than that of gorillas, chimpanzees, and bonobos in eastern Africa’s Great Rift Valley, one that was more dry, but with drinking water still available, and with greater exposure to the elements. This is where members of the genus *Australopithecus* developed, in which newfound defining features included a modified skeletal arrangement that allowed for bipedal movement and an ability to assemble and subsequently use stone tools. While the australopiths did not show much brain development, members of the genus *Homo* showed more substantial brain

development, and exhibited refined abilities in the construction of tools, particularly with an emphasis on an ability to base such toolmaking on a plan constructed prior (Wilson, 2008). Eventually, around 200,000 years ago, the *Homo sapien* species emerged, characterized by the forging of a diverse array of tools and the production and use of decorative items. A subgroup of this species migrated to other areas of the world, and those that possessed the abilities necessary to withstand the features of their new environments were able to survive (Wilson, 2008). These achievements made it possible for substantial brain development that led to artistic creations, artifacts, and other cultural engagements approximately 50,000 years ago, in addition to the cultivation of plants and livestock approximately 9000 years ago, which helped foster the establishment of more sizable population centers (Wilson, 2008). At some point during the evolutionary process, expansions in brain size occurred, and *Homo sapiens* acquired an ability to engage in vocal language production via anatomical changes, alterations in the length of time in which infants and children developed were observed, various artifacts were produced and moved from their places of origin, migration patterns were apparent, coordinated group activities were evidenced, and genetic variations were observed (Wilson, 2008).

Evolutionary influences to embodiment as they relate to human cognition are being investigated in an attempt to determine how and why human social cognition arose, as well as to more comprehensively recognize its significance to our cognitive development. If we compare our modern abilities to those of other existing species, we can use the information obtained to more accurately and holistically investigate the cognitive capacities that our common ancestors held, in addition to the diverse ecological environments and social arrangements that prompted certain cognitive abilities. For instance, one ability of particular interest that was heavily influenced by elements of embodied cognition includes those in the realm of social cognition. In fact, our ancestors' participation in social-cognitive activities may have been the catalyst for more complex cognitive functioning (Wilson, 2008). Such collective behaviors may have led to the development of theory of mind, or the capacity for appropriately understanding, interpreting, and hypothesizing about the accrued knowledge, thoughts, and perceptions of others. For example, studies have indicated that non-human primates, dolphins, and scrub jays have the potential to understand and engage in eye gaze behaviors, deceiving behaviors, and manipulative behaviors according to the perceived levels of knowledge of other primates (Wilson, 2008). In addition, the social-cognitive abilities of fairness, reciprocity, morality, and justice, even at the expense of the individual in advocating for another's punishment for committing wrongdoing have been explored, with evidence supporting biological underpinnings (Wilson, 2008). Further, research has been conducted on the exploration of empathetic behaviors in other animals, and such research supports that this noted social awareness and these social capabilities were influential in the development of modern human brain size, intelligence, and cognition, and played a role in our teaching, cultural transmission, and complex communication abilities that later aided in language formation and production and symbolic thinking abilities (Wilson, 2008). Other attempts to study embodied approaches to understanding cognitive functioning from an evolutionary perspective

include the representation of language and abstract concepts, spatial relations concerning abstract quantities (numbers, time, etc.), the use of gestures as a means of enhancing cognitive abilities, and the off-loading of information to body-based or environmental resources (Wilson, 2008).

As referenced by Wilson (2008), studies have indicated that some animals other than human beings, some of which include scrub jays, bonobos, and orangutans, for example, are able to plan ahead to an extent and perform abilities that equate to “mental time travel.” “Mental time travel” refers to the ability to envision future situations based on the recollection of past experiences, which, in a human being, has been shown to be perceptually, experientially, observationally, and neurologically comparable to the process of recalling information stored in one’s episodic memory register (Wilson, 2008). This is viewed as a means of considering which actions to take in the present moment, and, in order for such occurrences to be attributed to that of “mental time travel,” they must involve the process of directing attention to the future and contemplating consequences that may ensue based on certain behaviors, and exceed in complexity those behaviors driven by inherent biological means or by basic learned associations (Wilson, 2008). In the former case, such a behavior would include an extensive search for water, and in the latter case, such a behavior would include a behavioral modification that would lead to a desired reward.

Some examples concerning planning abilities that exceed those that result from more simple behavioral experiences include the storage of food for future use in areas that were previously associated to be locations where food is more difficult to come by at that moment in time by scrub jays (Raby, Alexis, Dickinson, & Clayton, 2007), the selection, conservation, and transfer of various tools as a means of saving them for future use by bonobos and orangutans (Mulcahy & Call, 2008), and the long-term remembrance of specific events for an extended length of time of months to even years in great apes, specifically chimpanzees, orangutans, and bonobos (Lewis, Berntsen, & Call, 2019). In the last review described previously, their findings suggested that these memories could be made more memorable in the ape’s mind based on an event’s surrounding information that made it more distinctive, and they also have been shown to follow a similar logarithmic trend in forgetting similar to humans. Recall improved when contextual cues from the event were shown to the apes, which corresponds to encoding specificity and cue overload occurrences with human memory (Lewis et al., 2019). When considered in sum, these study findings suggest that when humans and non-human animals mentally construct these scenarios, which consist of information concerning members involved in the event, the event’s setting, associated interactions, and the event itself, information extracted from the episodic memory register is involved (Cheng, Werning, & Suddendorf, 2016). According to prior research, the construction of scenarios as they pertain to “mental time travel” abilities differ between humans and non-human animals primarily in the use of semantic information; while certain non-human animals possess the ability to encode, store, and

retrieve episodic memory information, humans seem to be unique in their ability to construct, reflect upon, and critically examine a variety of scenarios (Cheng et al., 2016).

Embodied Cognition: Background, History, and Conflicting Views

Late philosophy professor John Haugeland describes embodiment in his essay entitled “Mind Embodied and Embedded” as an “intimacy of the mind’s embodiment and embeddedness in the world[,]” in which the brain, the body, and the external environment together constitute mental states and cognitive processes (2000, p. 208). Embodied cognition underlies the storage of the multifarious interactions between the internal mental processes of the agent, the agent’s body, the external environment, and the related contextual information, social and beyond, which ultimately allow for the enactment of more complex sensorimotor activities. As such, these reciprocal relationships together constitute the embodied “self” that is influenced by these interactions, and that can subsequently play a role in the many opportunities that are presented with the initiation of action and behavior (Cappuccio, 2015). Therefore, an agent’s reasoning capacity is motivated by elements of the human brain, the body, and personal experience, which suggests that our cognitive abilities are embodied in a manner that constitutes the similarities between the processes utilized in perception and action and the processes utilized in concept modification and reasoning (Aizawa, 2015).

In a similar manner, Schiavio and colleagues (2019) define embodied cognitive science (ECS) as the incorporation of both physical resources from an organism’s entire body and its environment in the enactment of cognitive processes. Accordingly, the reciprocal relationship between the mind, the body, and the environment directly influences a human being’s ability to think, reason, feel, and interact with others, moving beyond more basic stimulus-response mechanisms (Schiavio et al., 2019). A key feature that is outlined with ECS involves the social element to learning, cognition, and bodily experience, which differs from more traditional approaches to cognition that focus more on the internal cognitive processes associated with the individual. A key element of ECS includes the interconnectedness between perception, action, biological structure, reflection, and intersubjectivity, in which the mind’s many capabilities are realized from the various interactions between the mind, the body, and the unique social, cultural, and physical features of the external environment that the organism is situated in (Schiavio et al., 2019). Further, Cappuccio (2015) illustrates how, when analyzed from an embodied cognition perspective, many of the actions and behaviors that are executed in the external world are executed on a subconscious level:

> “[T]he embodied approaches to cognition emphasize the role played by the direct responsiveness to a familiar environment, developed by a situated agent through ‘unreflective’ involvement of a perceptual and motoric kind (Rietveld, 2008), without the mediation of stored heuristics, propositional

> contents, or encoded algorithms: the kind of situated adaptiveness enacted through the body is not only more fundamental than declarative and symbolic intelligence (in fact, the kind of sport skills mastered by the athletes don't seem to presuppose the actual capability or even the theoretical possibility to analytically describe how they work); it is also pervasive in and constitutive of 'higher' and more intellectually detached cognitive faculties (e.g., propositional judgment, conceptual categorization), to the point that the latter struggle to develop if the former is deficient." (Cappuccio, 2015, p. 214).

These subconscious, more or less automatic actions and behaviors can result in odd occurrences, such as the later remembrance of an out-of-place observation during engagement in a regular daily activity, the missing of an important turn while driving to a friend's house due to being in "autopilot mode" and automatically heading to a more frequently visited location, or the making of mistakes during a musical or athletic performance when other external influences are internalized or when focusing on the musical score, the athletic routine, or the expected move in the presented situation. The latter example refers to the occurrence of "choking under pressure" or the "choking effect" among highly skilled musicians and athletes, despite intense preparation and skill.

The classical cognitivist/computational approach highlights a primary focus on internal mental processes that occur regularly in the human mind. Early philosophical considerations of the mind and its various cognitive processes were fundamentally dualist, viewing the mind and the body as separate entities. Two well-known proponents of this view were Plato and Descartes (Illundáin-Agurruza, 2013; Raab & Araújo, 2019). The information processing model is often referred to, which compares the mind's functional abilities and processing power to that of a computer, indicating a rule-oriented, representation-forming, attentive, contemplative, reflective, and aware mind (Illundáin-Agurruza, 2013). Further, the more traditional approach to understanding human cognition assumes that the capacity for intelligent functioning requires logical processing, particularly through the manipulation of symbols, in which amodal information is perceived, unaltered from any contextual influences, from the external environment and directed inward for further processing (Cappuccio, 2015). George Lakoff and Mark Johnson (1999) differentiated between the earlier approach to understanding human cognition in the field of cognitive science as "first generation cognitive science," which they referred to as "disembodied mind," and the more recent approach to understanding as "second generation cognitive science," which they referred to as "embodied mind" (Garbarini & Adenzato, 2004). The first generation of cognitive science was defined by an overemphasis on a computational mechanism for achieving internal mental processing, viewing these processes as a form of software, excluding external influence, or cerebral hardware in their computational metaphorical model for cognitive functioning at this time (Cappuccio, 2015). "First generation cognitive science" involved the conceptual interpretation of reason by a Cartesian means (i.e., Descartes' philosophy), in which the mind was viewed as a separate entity to the body and its associated

engagements (Cappuccio, 2015). In comparison, the second generation of cognitive science instead places emphasis on the reciprocal relationship between mind and body, cognitive processes and physical actions, and rational schemas and sensorimotor schemas (Cappuccio, 2015). Further, the term "embodied" corresponds to interrelationships between both the body's physical or biological organization and the information acquired from experiences, taking into consideration "the living, moving, suffering, and enjoying body" (Cappuccio, 2015, p. 101). As such, the embodied cognition perspective concerns both the mapping of cognitive functions to the neuroanatomy of the brain and the grounding of cognitive functions in the agent's sensorimotor experiences (Garbarini & Adenzato, 2004).

Cognitive mechanisms have historically been understood to motivate and generate behaviors in some fashion, which, if we consider from an embodied cognition perspective, describe an embodied actualization of cognitive function in the agent. For instance, Daniel Dennett (1996) suggests that the exceptional intelligent abilities that humans possess in comparison to other animals is primarily due to our use of the environment to our advantage. In particular, he attributes such intelligence to "our habit of off-loading as much as possible of our cognitive tasks into the environment itself—extruding our minds (that is, our mental projects and activities) into the surrounding world, where a host of peripheral devices we construct can store, process, and re-represent our meanings, streamlining, enhancing, and protecting the processes of transformation that are our thinking. This widespread practice of off-loading releases us from the limitations of our animal brains" (Dennett, 1996, p. 134-135). We can thus consider our experiences and the stored knowledge obtained from these experiences as driving forces that enhance our cognitive or intellectual abilities, which, in turn, enhance our behaviors and performances. Further, the use of tools present in the environment allows us to accomplish tasks to a higher extent without heightening the amount of work that our minds must engage in in order to carry out these tasks. These tools could also facilitate accomplishment while reducing our cognitive engagement. For example, the use of a calculator may allow us to accomplish more, such as in the case of more rapid and more precise arithmetical problem solving, but it may also result in a lowered cognitive engagement over time, which could be positive in that it frees up additional space for other things, but it would also mean that arithmetical abilities are not being used as frequently (Aizawa, 2015). In another example, we are able to develop fine motor skills as we learn to handwrite and type. These abilities allow us to externally visualize, organize, and record what we are thinking, and subsequently redistribute it, share it with others, and reference the information at a later date (Wilson, 2016). As such, this action functions as an external memory device, which frees up additional space in our working memory for other tasks that may become more pertinent in the near future, and thus serves as a "cognitive technology" (Wilson, 2016).

Existential phenomenology is also a relevant approach to understanding embodied cognition. Existential phenomenology explores the defining features of "human," "human nature," and a human's knowledge and awareness of one's mortality as an ever-approaching occurrence through a perspective that

emphasizes the reciprocal relationships between the external world, the body's movements, and the internal world consisting of the mind's various cognitive processes (Allen-Collinson, 2009). Maurice Merleau-Ponty was the first known theorist to bridge the gap between existentialism and phenomenology, and Martin Heidegger, while he neglected to use the existentialist classification in his work, is also thought of as a contributor to the developing field of study (Allen-Collinson, 2009). In this view, the human being's body is considered to be the central figure of perception and experience, which serves as a mediating factor that grounds abstract information present in the environment with subjective consciousness and experiences. Merleau-Ponty associates human behavior to that of acting in and being a part of the external world, emphasizing interrelationships between physiological actions and psychological phenomena (Allen-Collinson, 2009).

One relevant example provided by Merleau-Ponty includes that of phantom-limb pain, which describes the reported experience of pain in a limb that no longer is attached to the body. As such, the lingering pain is not a direct result of entirely physiological or entirely psychological origin, since the individual suffering from this bizarre occurrence is aware of the limb no longer being attached to the body, but still experiences some sort of virtually unexplainable phantom pain that would suggest its physical existence (Allen-Collinson, 2009). Interestingly, mirror therapy as a form of treatment, which gives the illusion of an intact and appropriately moving limb that was previously lost with the proper positioning and use of a mirror that reflects the limb that is still attached to the body, has helped to alleviate phantom limb pain in a number of patients (Foell, Bekrater-Bodmann, Diers, & Flor, 2014). The pain relief that many experience following treatment offers support for the embodied cognition and the existential phenomenology perspectives, as being presented with an illusion of an intact limb and moving, clenching, and releasing tension in that limb while looking at the reflection in the appropriately positioned mirror has been shown to alleviate much of the pain experienced in the phantom limbs of many individuals.

Another proponent of the embodied cognition perspective is psychologist Eleanor Rosch. Rosch theorizes that we organize concepts according to specific categories: one refers to the mind's hierarchical organization of information into various categories, which she calls the "vertical level," and the other refers to the further division of concepts within one level of the "concept hierarchy," which she calls the "horizontal level" (Garbarini & Adenzato, 2004). Rosch further delineates that, with a horizontal organization of concepts, different categories often develop according to prototypes, or objects whose defining features and characteristics align with that of objects that serve as "ideal representations" of these categories. Within the vertical organization, a more elemental and inclusive level of categorization is established, encompassing categories that can, without the use of considerable cognitive effort, reflect the characteristic organization of objects recognized in the external environment (Garbarini & Adenzato, 2004). Rosch also describes two principles of categorization: the first is referred to as "the principle of cognitive economy," in which the amount of cognitive effort utilized by an agent when distinguishing

between two stimuli must take into consideration how favorable the newfound knowledge is when one considers the agent's intentions, and the second is referred to as "the principle of the perceived world structure," in which the information present in the external environment is thought to be perceived by the agent in structured form, as opposed to a jumbled mess of arbitrary and erratic attributes (Garbarini & Adenzato, 2004, p. 104).

In reflecting upon Gibson's theory of affordances and the "realist" nature of the object as discussed previously (see Introduction), although the functional attributes that describe an object are meant to remain unchanged as inherent characteristics of the object, Rosch emphasizes the necessary perceptual processes and motor skills that must exist in the form of stored knowledge in the agent's mind in order for the agent to appropriately identify the object's functional attributes, so that the object can be effectively ascribed to a purposeful scheme that represents the information essential for the interaction (Garbarini & Adenzato, 2004). Accordingly, Rosch's interpretation of this phenomenon further accentuates the importance of considering the agent's perceptions and sensorimotor knowledge and experiences in conjunction with the metaphysical nature of the object itself (Garbarini & Adenzato, 2004). Thus, her view differs from that of Gibson primarily in her claim that the practical needs of the agent that interacts with a feature of the external world constitute the resulting perceptual information that is discerned from the object, which differs depending on the type of agent that is viewing the object (i.e., humans or non-human animals). While many non-human animals are primarily driven by biological needs, human beings can also be influenced by social and cultural needs (Garbarini & Adenzato, 2004).

Rosch's theory of categorization can be applied to an example that concerns our brain's ability to recognize movements in the external environment with its population of mirror neurons, which are known to fire both when the agent executes an action and when the agent observes another agent executing that same action (Garbarini & Adenzato, 2004). Interestingly, these neurons appear to become activated in groups, and the same groups of neurons fire in response to related observations and/or actions according to a common purpose achieved by these observations/actions (Garbarini & Adenzato, 2004). This occurrence offers support for Rosch's theory that observations of actions and the performance of these actions are coded in the brain through a categorization mechanism based on the associated actions are used for. In addition, these categorizations are evolutionarily advantageous, as these formed associations allow for the rapid generation of a conceptual representation that relates to the object, its purpose, and related information (Garbarini & Adenzato, 2004). Finally, mirror mechanisms and the mental schemas that hold categories of information concerning the related actions associated with various objects can assist in our understanding of others' behaviors (Garbarini & Adenzato, 2004). These applications offer further support for Rosch's influential theories concerning our mind's organization of information through the formation of categories.

Two other influential theorists, named William T. Powers and Maurice Merleau-Ponty, offer relevant perspectives concerning the embodied cognition approach to understanding human cognitive processes. Powers (1978) details another fundamental characteristic of embodied cognition in his description of how agents perform goal-directed behaviors according to their perceptions of the fluidity of the external environment. According to Powers' perceptual control theory, how the external environment is perceived is dependent upon the current skill level of the agent and the actions of that agent. The ways in which the external environment is changing, based on how closely it resembles that of the ideal goal state to the agent, is what drives the agent's actions and helps the agent to determine if any quick adjustments need to be made before and during the execution of the action; these systems are referred to as sensorimotor feedback loops, which help to establish the flexible and predictable characteristics of skillful human sensorimotor actions. These feedback loops also appear to allow for the less conscious, more automatic execution of actions as one becomes more experienced in certain behaviors and activities (Cappuccio, 2015).

In comparison, Merleau-Ponty (1945) discusses two specific occurrences of embodied cognition, which he refers to as "tacit knowledge" and "knowledge in the hands," that further delineate how actions and behaviors are influenced by context and experience (Cappuccio, 2015). He describes these phenomena through an athletic context, addressing how athletes have traditionally been attributed with having "good feet" and "quick hands" in accordance with their perception of their own performance and of the performances of the athletes around them in their external world, in addition to the appropriate mental processes that follow from these interpretations (Cappuccio, 2015). This concrete understanding and subsequent storage of practical contextual information, the subjective experiences that relate to both intrapersonal and interpersonal knowledge concerning relations, and other external occurrences and influences are, together, what constitute "tacit knowledge" and "knowledge in the hands" according to Merleau-Ponty, rather than solely considering conceptual knowledge that is formed by more unambiguous, specific instructions, accumulated heuristic methods and principles, and amodal representations (Cappuccio, 2015). As such, an athlete's "conceptual understanding and decision-making capabilities build first of all on her situated expertise, i.e., on the development of a direct responsiveness to the surroundings, a readiness to anticipate and take advantage of the opportunities of action that the others cannot see" (Cappuccio, 2015, p. 213).

Emotion, Physiology, and Embodiment

Celeste Snowber, dancer, writer, educator, and associate professor at Simon Fraser University, beautifully describes the benefits of movement as it relates to dance in her article entitled "Dance as a Way of Knowing" (2012): "Movement has the capacity to touch us physically and emotionally at our roots, provoking the deepest emotions, from love to fear to joy to abandon[ment]" (p. 56). Snowber illustrates

these benefits of movement through dance, which she views as an activity that allows the engager to cultivate emotional intelligence and express the inner emotions in a creative, fulfilling manner. Although human beings have traditionally viewed feelings and emotions as an individual's subjective cognitive or conscious state, our emotions can often be sensed by others, due to external physiological cues from our facial expressions, our facial appearance (flushed, pale, sweaty, etc.), or by the way that we carry ourselves (Robinson, 2007). In particular, philosopher and author Jenefer Robinson (2007) discusses how human beings and other animals use their emotions in order to interact with their physical and social environment, whether it be, in the human's case, with other performers, the audience, judges, referees or other activity moderators, or a combination of these external influences in order to effectively express themselves during performance. In her novel entitled, *Deeper Than Reason: Emotion and its Role in Literature, Music, and Art* (2007), Robinson describes how, in addition to human beings, a variety of living things, from fish and insects to non-human mammals, utilize emotions as a means of interacting with their surroundings, which, in turn, are impacted by both their own physical limitations and by the constraints that are established in their current environment. Humans experience a wider range of emotional states than do other organisms, which can be attributed to their language acquisition abilities. Accordingly, Robinson proposes that organisms, both humans and non-human animals, utilize emotions as a means of assessing the impact of their immediate surroundings (Robinson, 2007). In the case of human beings, both the internal environment, including thoughts, opinions, and other cognitive processes, and the external environment, including physical, social, and other extrinsic pressures and influences that exist outside of the mind, can motivate the materialization of various emotional responses (Robinson, 2007). A rather basic example of an external embodied influence on our emotional state includes the sudden boost in mood that a runner experiences after completing a challenging race (the "runner's high").

The "cognitive" or "judgment" theory of emotion is presently the most generally accepted theory of emotion, and it offers an explanation for why emotions lead to certain cognitive and physiological responses that differ in intensity based on the individual and the associated influences present in the immediate environment, and how they coincide with evaluative judgments. A fundamental interpretation of emotions relates them to feelings, which can range from anger to jealousy, elation, or nostalgia (Robinson, 2007), but, in a more embodied context, emotions are more complicated**.** Humans also frequently perform evaluative judgments, which are essential to experiencing emotions (Robinson, 2007). Evaluative judgments refer to judgments that serve to assess the environment in a manner that considers a situation according to the agent's wants, wishes, desires, values, interests, and goals (Robinson, 2007). For instance, from an observer's perspective, interpretations of certain emotions based on presenting physiological features may overlap with signs that are associated with other engagements (Robinson, 2007). Accordingly, an observer's ability to differentiate between the recent cessation of physical exertion and nervousness could potentially be challenging if the physiological symptoms of the individual being observed presents with a flushed, sweaty face, sweaty palms, shakiness, and shortness-of-breath.

Similarly, physical exertion and excitement present with much the same symptomatology, although they result from quite different phenomena. In considering this occurrence, Robinson asks, “What, after all, is the big difference between the trembly feeling I get when I'm in love and the trembly feeling I get when I run up the stairs too fast? In the one situation my feeling is caused partly by a rapid heartbeat brought on by a sudden burst of strenuous exercise; in the other situation my feeling may be (partly) caused by a rapid increase in heartbeat, but in this case the increased heartbeat appears to be caused not by some physical activity I'm engaged in- such as running too fast- but by a judgment that I make, the judgment that my beloved has arrived and that he is a darling of my heart.” (2007, p. 7). While these two instances present with similar physiological features, the emotional response remains more of a cognitive or conscious activity, overall meaning something more than a simple response to physical exertion. Robinson (2007) also expresses how different emotions, or lack thereof, can facilitate similar tendencies and behavioral responses in instances such as the following:

> “If I care for you and cherish you out of love, then my behavior is plausibly construed as a result of my judgment that you are the darling of my heart, a wonderful person, and a joy to be with. Alternatively, if I care for and cherish you solely out of a sense of duty, then my caring for and cherishing you is caused by my sense of duty; I do not judge you to be the darling of my heart; I may be indifferent to you or even dislike you.” (Robinson, 2007, p. 7-8).

Our experiences with music are very emotion-driven, whether we are listening to music on a personal device, listening to a live musical performance, participating in a group rehearsal, or participating in an ensemble performance. As such, a musical experience in any form fundamentally encompasses what a human being sees, does, feels, listens to, performs, recalls, or otherwise ponders as it relates to music (Cox, 2016). Author and educator Arnie Cox describes affect as a term that comprises all responses that relate to feeling, such as emotions, moods, urges, and desires in his novel entitled, *Music and Embodied Cognition: Listening, Moving, Feeling, and Thinking*. Also regarded as elements of affect include “feelings of exertions, balance, alertness, warmth, and other sensory experiences that, by themselves, do not constitute any particular emotion and yet are integral to the feeling of various experiences” (Cox, 2016, p. 177). Musical affect specifically refers to the subjective feelings that an individual experiences during musical performances and after exposure to or engagement with some sort of musical impetus (Cox, 2016). Affective states, which result from and are attended to in specific instances of overall life experiences, are influenced by more specific musical experiences, among others (Cox, 2016). In particular, when an individual experiences an affective response to music, feelings of a certain kind often emerge, accompanied by an inability to attribute them to a definitive cause or effectively name or describe them (Cox, 2016). In the following quotation, Jenefer Robinson illustrates the powerful impact of music on emotional experiences regarding the past, present, and future:

> "[M]usic can mirror the streams of emotional experience: the many interrelated currents going on simultaneously, perhaps reinforcing one another, perhaps in conflict. Music can express the way one emotion morphs into another over time, how the stream turns in another direction or returns peaceably to its original channel. Music can convey changes and modifications in emotion, a sense that things are going from good to bad or from bad to good, a sense that desires are gratified or disappointed, a sense that memories have engulfed a person or been swept away. Music can also convey blends of emotion, a bittersweetness that is a blend of hope and resignation or sadness and nostalgia." (Robinson, 2007, p. 312).

The physiological element here could lie in bodily expressions, such as facial expressions or "moving to the music," or, in the case of musicians, the act of playing an instrument or supporting one's breath and producing sound in singing.

Finally, it is important to discuss the visual elements of the performer when it comes to musical performance. During musical performances, musicians may show certain facial expressions or engage in certain bodily movements that are representative of crucial musical changes in dynamics, tempo, rhythm, modulation, or in musical descriptions (e.g., *adagio* or *intense* descriptions for particular sections of the piece), for example, that occur in the composition that is being performed as a means of enhancing their own musical experience with the piece or that of the audience's takeaways regarding its musical meaning (Cox, 2016). The musical experience from the listener's perspective, based on performers' facial expressions, movement patterns, or other embodied expressions can either be predominantly consistent with what the listener hears, or it can be chiefly inconsistent with what the listener hears. Accordingly, how the musical performers are presented on the stage and their embodied forms of expression during their performances can influence the listeners' subjective thoughts, feelings, and emotions concerning the performance overall (Cox, 2016).

Embodiment in Music

Viewing music cognition and performance from an embodied perspective requires the consideration of musical experiences and the meaning that is acquired from them. How does the process of music cognition occur? Similar to the mechanisms by which human beings initially learn new skills through vicarious learning, or imitation, this process likely begins with the act of imitating musical sounds and the associated bodily movements that are enacted in order to generate these sounds (Cox, 2016). For instance, an individual would initially get a sense of how to play the violin by observing how one holds the violin, how the fingers of the fretting hand are placed on the strings to play a certain note, and how the bow is gently positioned on the instrument in order to produce its characteristic sound. As such, both the mind and the body are able to make sense of the sounds that are generated by a musical instrument

through sound-producing actions (Cox, 2016). Musicians engage in musical embodiment on a regular basis, as they consider the bodily movements (e.g., finger positions on stringed and key instruments, bow location on many stringed instruments, the key locations on key instruments, the lip positioning/tightness that corresponds to the clarity of lower and higher notes in woodwind and brass instruments, etc.) that they must execute, appropriately plan for sudden key changes, accidentals in the musical composition, and other elements of the piece being performed, and they engage in the act of performing, whether it be during select group or ensemble rehearsals or the actual stage performance. Importantly, all of these considerations and actions require the engagement of the physical body. In a similar manner, an individual who listens to music, speculates about music, or recalls prior musical engagements or performances is involved in some form of vicarious learning, or imitation (Cox, 2016). In this context, both overt and covert imitation are applicable, in which overt imitation describes the more deliberate mimicking of actions and behaviors, while covert imitation refers to the more passive act of observing the actions and behaviors of another and the subsequent cognitive processes and imaginative thoughts that ensue.

In reference to his mimetic hypothesis (where *mimetic* refers to imitative behavior), Arnie Cox (2016) further differentiates between these two types of imitation by calling overt mimetic behavior *mimetic motor action (MMA)* and the (covert) associated muscle-related neurological mechanisms that do not result in overt action but instead constitute mental representations, cognitive processes, and imaginative thinking as they relate to action and behavior *mimetic motor imagery (MMI)*. Further, MMI encompasses imagery both in the form of conscious, voluntary mechanisms and autonomic mechanisms that could occur either with or without mental awareness (Cox, 2016). While the imagination of an embodied musical activity serves as an intentional, conscious occurrence in the visualization of motor imagery, one that would serve as an example of MMI if the agent imagined playing the flute in Ian Anderson's distinctive style, the actual imitation of Ian Anderson's playing style and mannerisms in a private flute lesson with Ian Anderson would serve as an example of MMA. The two underlying principles of Cox's hypothesis follow that:

1. "Part of how we comprehend the behavior of others is by imitating, covertly (MMI) or overtly (MMA), the observed actions of others"
2. "Part of how we comprehend music is by imitating, covertly or overtly, the observed sound-producing actions of performers"
   (Cox, 2016, p. 12).

Some additional salient assumptions of this hypothesis, as outlined by Arnie Cox (2016), follow that: (1) much of the musical sounds that are heard in the world serve as evidence that the motor actions and behaviors of human beings generate these sounds; (2) a human being's ability to comprehend environmental occurrences and other human and non-human animal actions and behaviors can partially be attributed to mimetic behavior (MMI and MMA); (3) MMA and MMI constitute bodily representations of

observed actions and behaviors; (4) mimetic comprehension occurs in response to visual, auditory, and/or tactile stimuli; and (5) musical imagery is partially considered to be a type of motor imagery.

Cox also discusses the role that the metaphor plays in our conceptualization of music as it relates to the conceptual metaphor theory proposed by Lakoff and Johnson, with a “focus on the bodily experience that motivates and grounds metaphoric reasoning (that is, reasoning via metaphor)” (p. 58). The metaphor is used as a means of conceptualizing fairly abstract experiences (i.e., the recollection of ideas, concepts, and experiences that are not explicitly seen or touched, such as time or music) with the application of a more concrete experience (Cox, 2016). He associates *metaphor* as similar in meaning and use to *imitation*, as the metaphor is often utilized by the mind in the description and understanding of a conscious, intentional occurrence. Further, Cox explains that we form concepts that can be metaphorically represented from information that we pull from our environment according to our experiences, and this process can be divided into three conceptualizations: (1) we conceptualize concrete, visible objects; (2) we conceptualize physical actions that are enacted on objects (e.g., playing an instrument), that involve movement across a physical space (e.g., walking), and that divert focus to the agent’s body as the concrete object (e.g., breathing); and (3) we conceptualize abstract experiences (e.g., time, perceptiveness, comprehension) (2016). In order for the process of conceptualizing more abstract ideas to remain useful, human beings compare these hypothetical concepts to more primitive, concrete concepts (Cox, 2016). As such, these more abstract musical conceptions that may be more difficult to grasp independently can be applied to MMI as formed by musical experiences, or, in accordance with Lakoff and Johnson’s conceptual metaphor theory, to sensory (visual, motor, etc.) image schemas and musical schemas that hold certain musical elements and forms (Cox, 2015).

In regard to ensemble performances in music, in order for a successful musical performance to occur, musicians must be aware of their fellow musicians around them, and be able to appropriately respond to and modify behaviors as needed according to environmental influences. Ensemble performers must consciously be considering and attending to various feedback mechanisms, which include the instrument being played, the musical score, fellow performers, the audience, the conductor, and other environmental factors that may impact performance if such information is ignored. For instance, highly skilled musicians often show great adaptability and quick responsiveness when they are presented with unforeseen circumstances during performances (Schiavio et al., 2019). For example, when the tempo of a musical piece speeds up or slows down suddenly, in order to prevent the performance from falling apart, musicians must rapidly respond appropriately, which involves the production of suitable and innovative actions. In order for these adjustments to be made quickly, they are most likely primarily accomplished via an automatic process, as the conscious attentiveness to the issue and subsequent generation of thoughts would more likely interfere with the tasks that are currently being attended to (Schiavio et al., 2019). It is important to note that, any time members of a music ensemble perform, the ways in which behaviors are

coordinated can never be completely predetermined or exhaustively rehearsed with the expectation that everything can be anticipated, as these behaviors are continually influenced by features of the external environment (Schiavio et al., 2019). In a similar manner, individual musicians have a specific role that they contribute to the ensemble as a whole, but these “individual” roles are always cultivated, altered, and shaped accordingly, based on both the goals and objectives of the ensemble and on the constraints that reflect the collective skill level of the ensemble (Schiavio et al., 2019). As such, each individual musician, when considering the musical composition being performed and the feedback that is perceived from the audience, is expected to be consciously engaged and rapidly able to modify prior interpretations concerning the present situation, enacting micro-adjustments to their own performance in a manner that is consistent with the team effort (Schiavio et al., 2019). As noted prior, while some of these micro-adjustments become more automatic and less cognitively engaging over time, others still require attentiveness in order to constitute a successful ensemble performance.

A fairly explicit instance of an embodied application of music involves the construction of a choreographed gymnastics routine, in which athletic skill, music, rhythm, and expression together constitute an embodied performance. This section specifically focuses on rhythmic gymnastics, in which training is heavily directed at a sharpened musical sense, skills in rhythmicity, and emotional expressiveness during performance, in addition to the muscle flexibility, strength, and stamina required for competency in the sport (Chirazi, 2021). Rhythmic gymnastics is a unique sport in its incorporation of great athleticism with its variety of difficult skills, its utilization of five objects (a rope, a hoop, a ball, clubs, and a ribbon) in a series of individual and group exercises that involve skillful tossing to other performers, waving, and the performance of challenging skills, its elements of dance, and its inclusion of choreographed routines set to musical accompaniment. The individual and group exercises are performed, and routines are intertwined with beautiful elements of dance and difficult skills, and accompanied by a musical piece, in which artistic movements, executed with an object, are performed in perfect alignment with the musical accompaniment (Chirazi, 2021).

During group performances, gymnasts engage in a movement-driven, embodied language with the other performers, as well as with the judges and audience, requiring the directing of attention to the bodily skills being executed during the routine itself, the tasks being accomplished with the object, and the relative positions of the other performers in the immediate environment (Chirazi, 2021). A similar form of movement-driven, embodied communication also occurs during individual performances, only without the influence of the other group performers. These gymnasts must be quick to react to any mistakes made during the performance, as the timing of the choreographed routine with the musical accompaniment could easily be impacted if a ball is dropped during performance, or if a stumble or fall occurs. For this reason, conscious awareness of the gymnast’s body in space in relation to other performers in the case of the group routine and of the object’s location in relation to the gymnast during performance is a necessary

component to successful performance, so that quick adjustments can be executed successfully in the event of a mistake.

Embodiment in Dance

The artistic expressions that are exhibited in dance and the strong creative element in both choreographed and improvised dance create an elegant example of an embodied activity. Engaging in dance, as Celeste Snowber articulates, “accesses many kinds of knowledge beyond kinesthetic intelligence, including visual, tactile, mental, cognitive, and emotional intelligence” (2012, p. 57). In acting as the dancer, through movements of various kinds, they are able to exert themselves both physically and emotionally as they carry on a conversation with the audience, the judges, and the other dancers in a group dance setting (Snowber, 2012). We can also view these movements in the form of gestures, which, through a means of artistic and emotional expression, encompass some form of interior psychogenic information held by the dancer(s) that is portrayed to the exterior bodily level via gestures that can be perceived and interpreted by the audience (Chirazi, 2021). To further delineate this point, Marian Chirazi (2012) explains how the gesture can be viewed as a mediating factor that falls between mental operations (the inner self) and the physical bodily operations (the outer self), in which the observer, by viewing and extracting meaning from the gestures presented by the dancer(s), can eventually reach the core message behind the dancer’s or (dancers’) gestural form of communication. In focusing more on the perspective of the dancer, Snowber (2012) discusses the utility of the enactment of play through dance, particularly in enhancing the dancer’s introspective qualities. She argues that dance involves an imaginative, creative element that fosters a sort of learning through play. Thus, by engaging in dance, one can discover novel ways of moving, experiencing “hidden” emotions, or finding new forms of inspiration. She claims that engaging in this activity can be freeing, ridding the mind of restrictive inhibitions that often present as self-consciousness, and allowing concealed emotions to surface and be felt. In addition, practicing both choreographed dance and improvised dance allows individuals to enhance how external information influences their perception and associated mental states:

> “The body has constant data that speaks to us, whether it is the flurry in the stomach, the stretch of an elbow, or the abrupt contraction. Body data is the information that occurs in the present moment, the immediate present time, the ways we experience information through our bodies. The choreographer and performer have long known that the creative process is one of questioning and sifting, forming and unforming, making and remaking, and always a place of discovery. By dancing our questions, we can uncover the questions underneath the questions and open up a deep listening to the body’s knowledge.” (Snowber, 2012, p. 57).

Choreographed, intentional dance involves the expertise of a choreographer in creating a series of movements to be executed by the dancer. In this sense, the dancer must appropriately follow the directions of the choreographer and perform the sequence of movements accordingly. This involves the careful interplay between the internal mental processing and the external enactment of the desired series of motions based on this cognitive understanding (Chirazi, 2021). In addition, the body must have been physically trained in a manner that allows for the actualization of these movements and skills (Chirazi, 2021). As such, dancers must be able to depend on this proprioceptive information and have developed the physical strength, flexibility, and agility necessary to perform these skills. This skill development and process of learning a choreographed dance routine initially begins with conscious awareness of the body's movement in space, the various sequences of movements that must be completed in order to successfully perform a skill, and the complementary movements that other dancers must perform and their positioning in space in the case of choreographed group dance routines (Chirazi, 2021). With repetition and practice, once a level of mastery of the routine is achieved, these conscious movements steadily become "muscle memory," where the body is able to execute these movements without reflection and conscious thought, and sensorimotor activities can occur independent of the dancer's constant attention (Barrero González, 2019). This more habitual level of learning in choreographed routines allow room for more creative, expressive, and gratifying movements with a heightened ability to absorb other aspects of the dynamic environment, including the other dancers' expressions and skilled performances and the reactions of observers.

In improvised dance, rather than the dancer executing predetermined movements, the dancer now engages in spontaneous, improvised movements as a form of bodily, artistic, and emotional expression (Barrero González, 2019). The act of improvisation in the form of dance draws upon elements of affectivity, in which the dancer responds to perceptual spatio-temporal input according to their stored affective information by producing different bodily movements (Barerro González, 2019). As such, researcher Luisa Barrero González (2019) defines the fundamental components of dance improvisation as "the high levels of alertness of the dancer, a quick reaction system, a sensory-attentional system synchronized with the environment, and a focus toward the bodily movements that actually starts in the affectivity" (p. 95). An additional key feature of dance improvisation is the enactment of movements that do not require conscious thought and planning, as the physical body starts to take the initiative apart from cognitive processes and representations (Barrero González, 2019).

Embodiment in the Martial Arts

In considering embodied cognition from the perspective of the martial arts, similar, yet distinct, patterns of artistic expression and communication with other practicing agents are observed. In a particular martial art referred to as *Aikido*, which is known as "the way of harmonizing energy," elements of reciprocity,

non-competitiveness, and nonviolence are key defining features (Kimmel & Rogler, 2018, p. 198). As such, performance in Aikido encompasses preparation methods that emphasize flexibility and acclimation when presented with a series of movements, attacks, and other configurational and temporal influences that cannot be fully anticipated, which involves focused attention and physical training (Kimmel & Rogler, 2018). In addition, agents involved in Aikido primarily play a defensive role as the "defender" during an event with another agent that is instantiating attacks in the role of the "attacker." In order to succeed in the defender role, the agent must defend oneself from a variety of attacks made by the attacker, while also responding in a manner that disrupts the attacker's balance without causing injury but allows the defender to maintain a strong, steady stance that can withstand additional attacks (Kimmel & Rogler, 2018). These attacks may occur in the form of grabbing, thrusting, striking, knife, sword, or staff/spear attacks (Kimmel & Rogler, 2018).

Further, elements of cooperativity and co-regulation in various modality-specific instances are employed. During training, agents rotate between the attacker and defender roles, engaging in a form of communication dependent upon the other agent's actions and defenses (Kimmel & Rogler, 2018). The role of the defender is further illustrated below:

> "In this short bout of about 2–3 seconds, the defender seeks to (a) step out of the line of an attack either to the front or backside of the attacker (unless she executes a linear counterattack through a quick punch); (b) take up the blow, thrust, or grab by blending with the opponent's aggressive energy; and (c) disperse the attacker's energy in circles and spirals, turning it against her to break her balance. To prevent the attacker from still cutting downward with force, the defender must also have stepped out of the line of attack before contact. Now a defensive lever can be executed. The defender moves past the attacker with a second step. This involves one or occasionally two direction changes, usually at velocity minima that allow various possible continuations. Once the attacker's balance is broken the defender can optionally guide the opponent to the ground and apply a fixation" (Kimmel & Rogler, 2018, p. 199).

Accordingly, agents must consciously be engaged during trainings and performances, as they are continuously influencing and influenced by their own movements and the movements enacted by the opponent, in addition to other environmental/contextual occurrences (Kimmel & Rogler, 2018). The movements and configurations that are generated during this embodied "conversation" being held between both agents, in turn, influence the selection of, modification of, and extinction of various actions according to these interacting features of the performance, based on the relative positioning of each agent in physical space and the timing between each execution (Kimmel & Rogler, 2018).

Another central feature of Aikido includes the generation of appropriately co-regulated responses to an opponent's attacks with the utilization of fine adjustments, according to the principle that "blending with aggressive energy confers defensive advantage and the ability to control an opponent without harming [them]" (Kimmel & Rogler, 2018, p. 217). In this article, Michael Kimmel and Christian Rogler (2018) examine Aikido and the various movements and expressions made by performers through Gibson's theory of affordances (see Introduction). In this particular instance, affordances are viewed as dynamic and transitory in nature, based on the specific task being acted on, the agent's specific skill set, prior occurrences, and other social factors (Kimmel & Rogler, 2018). These researchers introduce the term, "effectivities," which refer to "the subject-sided counterpart of affordances" to describe how an agent's skill and other individual influences impact affordances (Kimmel & Rogler, 2018, p. 202). These effectivities, which influence an agent's ability to act on something, include, for example, an agent's strength, height, weight, physical fitness, agility, balance, perceptivity, and temporary training state (Kimmel & Rogler, 2018). As such, effectivities ascertain the types of affordances that can be made available or perceived by an agent according to their developed skill set, and the expertise in Aikido that is cultivated over time allows the agent to effectively perceive a greater number of affordances, quickly differentiate between them, and act according to the most time-sensitive and potentially damaging affordance during performances (Kimmel & Rogler, 2018).

As such, the defender is expected to harmonize and cooperate with the attacker's intensity and movements, which involves careful consideration of the attacker's expressions and the internalization of the principle of "minimal resistance" (Kimmel & Rogler, 2018). This behavior thus requires a keen attentiveness and sensitivity to subtle bodily movements and expressions, as task switching, modification, and termination may be necessary at any given instant in order to maintain this shared energy between agents (Kimmel & Rogler, 2018). This perception-action dynamic occurs in the practice of Aikido with the engagement of a multitude of elements, including readiness, posture, alignment, gaze, breath, tone, and attention (Kimmel & Rogler, 2018). These complementary actions require an ability of Aikido athletes to detect three different classifications of affordances that differ in duration: global affordances, transitional/main affordances, and micro-affordances (Kimmel & Rogler, 2018). While a global affordance refers to a task in its entirety and includes its execution (the longest time frame), a transitional/main affordance refers to a more specific kind of affordance that is characterized by transitions between elements and potential resulting states, and a micro-affordance refers to the many minor but significant alterations that must be made in order to complete various actions (the smallest time frame) (Kimmel & Rogler, 2018). Further, global task affordances involve the athlete's perceived estimation of when the opponent's balance will be completely broken according to their posture and other bodily characteristics, in which a general idea of the opponent's state is hypothesized. Transitional/main affordances particularly concern the development of intermediate motor movements as they sequentially lead to actions. Finally, micro-affordances depend on information obtained from multisensory feedback loops and the specific

task being performed, and work together to execute a smooth and effective action against the opponent (Kimmel & Rogler, 2018). Overall, these affordances are what constitute an embodied two-person relationship in the performance of Aikido.

Embodiment in Gymnastics: Nerves, Self-Concept, Coping, and Athletic Performance

When gymnasts practice and perform, they must be aware of their own body in space, the environmental influences that could impact their ability to effectively perform their skills, their own perceptions of the changing external environment as they perform, and the adaptability, quick decision-making, and problem-solving abilities that must be made as these factors influence them. Albert Bandura, in his novel entitled, *Self-Efficacy: The Exercise of Control*, established the theory of self-efficacy (Bandura, 1997), which investigated how an athlete's subjective view of their own athletic ability impacted their performance proficiency (Daroglou, 2011). Self-efficacy specifically pertains to a person's belief that the appropriate behaviors required to reach a specific end-goal can be executed (Weiss, Weise, & Klint, 1989). Bandura found that performance depended on the individual's belief in their skill level that allowed them to perform the task and the nature of the individual's environment as accepting and responsive to the individual's needs (Daroglou, 2011). More specifically, in the context of artistic gymnastics, researchers Maureen Weiss, Diane Wiese and Kimberley Klint (1989) determined that female artistic gymnasts exhibited varying levels of success in accordance with their subjective beliefs concerning self-efficacy. In particular, those who held higher expectations of success in the upcoming performance beforehand showcased a greater level of achievement than those who had a lowered self-efficacy (Daroglou, 2011; Weiss et al., 1989).

In comparison, self-concept, which refers to an individual's belief concerning oneself, has been shown as a moderating variable in athletic achievements in performances that concern physical activity, physical skills, health-related physical fitness, and exercise compliance (Marsh, Chanal, & Sarrazin, 2006). In this context, if athletes perceived their bodies and their physical abilities in a positive manner (a high physical self-concept), they were more likely to seek out, persevere, and accomplish their goals than those with lower physical self-concepts (Marsh et al., 2006). As such, Herbert Marsh's, Julien Chanal's, and Philippe Sarrazin's (2006) research in physical self-concept among gymnasts offered support for the reciprocal effects model, which states that an athlete's preceding self-concept influences later achievement and that preceding achievements influence later self-concept (Marsh et al., 2006). Their findings illustrated that an enhanced physical self-concept contributed to greater success experienced during performance, and, conversely, that enhanced performance skills contributed to a heightened physical self-concept (Marsh et al., 2006). These findings apply to the training effectiveness of gymnasts, which should involve a focus on developing both a gymnast's self-belief in their physical capabilities and their performance skills in order for a heightened self-concept to remain in the long-term (Marsh et al., 2006).

Psychological coping skills that gymnasts develop over time in response to previous adverse experiences can greatly improve their performance outcomes. Accordingly, John Fitzpatrick's study findings (1998) showed that the most frequent differentiating features between high and low levels of gymnastics performance were psychological factors, rather than simply attributing successful performance to athletic ability (Daroglou, 2011). These skills specifically encompass the cognitive and behavioral endeavors as a means of overcoming, diminishing, and learning to endure in a constructive manner the internal and/or external influences that are experienced in response to a stressful situation (Daroglou, 2011). Thus, it is important for gymnasts to learn to effectively manage such stress when presented with situational difficulties, regardless of an athlete's success, as coping with stress is not directly associated with the final result of that endeavor (Daroglou, 2011). This is especially important in gymnastics, as gymnasts, who often begin intense training at a young age if they hope to be competitive at the elite level, experience fairly high levels of stress both during competitions and in daily training (Daroglou, 2011). In particular, elite gymnasts often experience immense levels of anxiety, levels that are higher than those of athletes with comparable skill levels in other sports (Daroglou, 2011). Further, especially among young gymnasts, coach, parent, and teammate support is extremely valuable in fostering successful coping mechanisms when they are presented with stressful situational influences (Daroglou, 2011). Similarly, during a gymnast's adolescent years, coach and parental pressures to win competitions can induce the feeling of being "pressured to perform," and thus instill stress and nervousness (Daroglou, 2011).

Researcher Garifallia Daroglou (2011), in her study on gymnastics performance as it related to self-efficacy and coping skill development, determined that both of these factors together contributed considerably to performance success. She investigated self-efficacy levels using the Self-Efficacy Scale one day prior to competition at the at the Hellenic Championship of Rhythmic Gymnastics and the Hellenic Championship of Artistic Gymnastics, performance using the calculated final scores for each gymnast after competition, and coping skills during competition using the Athletic Coping Skill Inventory, which was completed directly after competition. Study results indicated that gymnasts who engaged in most of the coping skills investigated performed at a higher level than those who did not practice them. Gymnasts who achieved scores exceeding 75% of the maximum performance also showed higher scores in the coping with adversity, goal setting/mental preparation, confidence/achievement motivation, freedom from worry, and coachability portions of the Athletic Coping Skill Inventory, and a higher self-efficacy score (Daroglou, 2011). Accordingly, gymnasts who performed the most successfully (attained the highest performance final scores) claimed to have been able to manage their nerves during stressful situations by relaxing and competing in an enthusiastic and confident manner, without focusing on their performance anxieties. Prior to competition, they were aware of their goals and prepared for competition accordingly, taking into consideration their coaches' advice and instructions and feeling confident that they could perform to the best of their abilities. In comparison, those who reported lower levels of control over a

stressful situation, who had not established goals prior, who did not agree with or listen to their coaches' advice, and who lacked confidence in their abilities, did not perform as well (Daroglou, 2011). All in all, these findings suggest the importance of fostering the development of coping mechanisms in athletic activities that allow athletes to manage anxiety and cultivate healthy ways to control nerves during competition. As such, constructive internal mental processes and coping skills are key in athletic achievement during competition (Daroglou, 2011).

An Odd Phenomenon: Choking Under Pressure

Strangely, sometimes highly skilled athletes are suddenly unable to perform skills during performances that were extensively practiced beforehand, a phenomenon referred to as “choking under pressure” or the “choking effect.” These odd occurrences define moments when the subconscious bodily actions that have been learned and executed so well for an extended period of time are not able to be acted upon (Cappuccio, 2015). Further, these poor performances, even a failure to execute actions that are seemingly trivial for the athlete’s level of expertise, have been seen among elite athletes when they are performing at a “high-stakes” competition, where a phenomenal performance is expected by many (Cappuccio, 2015). Why does this occur? One explanation attributes this “choking under pressure” to an over-arousal due to overactive emotional and motivational systems that can occur during a performance, which disrupts the physiological activity by interfering with areas of the brain that are utilized in the execution of these actions (Cappuccio, 2015). Other factors that can contribute to this occurrence include one’s sensitivity to distracting stimuli, the difficulty level of the executed task, and the task’s strategic specifications (Cappuccio, 2015). These unfavorable implications of choking are likely attributed to the interference of external factors that attract attention away from the task at hand, the overuse of internal computational resources, or the interruption of well-established motor routines (Cappuccio, 2015). Yet another potential theory includes that of the self-monitoring theory, which describes the complexity of the smooth, adaptable organization of motion-specific knowledge that is quickly executed in real-time when necessary, and according to internal and external stimuli that the expert cannot be explicitly aware of it while executing it (Cappuccio, 2015). In comparison, the “constrained action hypothesis” emphasizes that the act of deliberately directing attention to an action that is being performed, including the lower-level actions that comprise the fundamental steps and processes necessary to execute that action, may result in “choppy,” less “natural” movements. This hypothesis could account for the supposed disruptions in bodily action that occur when individuals focus too much on cognitively analyzing a well-learned, “automatic” movement (Cappuccio, 2015).

Experiencing the “choking effect” as an expert athlete may also be attributed to some sort of disruption of automaticity. This explanation postulates that elite athletes practice and train rigorously for countless hours before they achieve a level of expertise, which allows them to perform these skills in a more

“automatic” way. This would explain why this “choking under pressure” occurrence only affects expert athletes who, in order to engage in a smooth, flawless, effortless performance, must be able to execute the action without deliberate thought. This occurrence is not seen in novice athletes, as they have not yet reached the level of expertise where these actions have been learned to the extent that they do not require conscious thought; instead they must be attentive and focused on the task being learned in order to execute it properly (Cappuccio, 2015). Similarly, Hubert Dreyfus’ phenomenological doctrine of skillful action is relevant in this instance, which describes how the mastery of learning an embodied skill is achieved when a conscious consideration of each step that leads to the execution of a particular skill moves to a subconscious, automatic execution that considers external environmental influences, referred to as “absorbed coping” (Cappuccio, 2015). Accordingly, the athlete reaches a level of expertise when their movements and skill executions are no longer determined by cognitive engagement with the step-by-step instructions of the skill, the rules that govern a successful performance, or the associated decisional procedures. Instead, they are able to engage in “a fine-grained sensitivity to complex configurations of contextual contingencies: in its most paradigmatic form, expert action occurs with neither decision nor control” (Cappuccio, 2015, p. 218). As such, these more habitual occurrences are still flexible and able to be changed according to the athlete’s sensorimotor circumstances and experiences and the contextual influences, especially if immense pressure is apparent during the performance, or if other distracting influences capture their more accessible attentional store.

Prior Experience and Success in Judging

Studies have also indicated that cognitive processes, such as perception, are influenced, in part, by environmental interactions, which highlights the possibility that perceptual errors could be influenced by previously stored memories (Luis del Campo & Espada Gracia, 2018). These prior influences could play a role in the decision-making abilities of referees during an athletic event, in addition to present behaviors and those acted upon previously (i.e., sequential effects) and the individual's positioning and visual perspective while an athletic event occurred (i.e., a positioning effect) (Luis del Campo & Espada Gracia, 2018). As such, a coach’s, a judge’s, or a referee’s perception of an athletic performance could be influenced by prior motor experiences, potentially contributing positively to the coach’s, judge’s, or referee’s ability to detect complicated, quickly executed skills. In particular, gymnastics is a notoriously difficult sport to accurately judge, due to the rapid execution of highly complex skills (Pizzera, 2012). Gymnastics judges, when judging performances, have a strenuous task of a non-ideal position in relation to the event being judged, sequential influences from performances judger prior due to the frequency of routines and the little time between each gymnast’s performance, and the risk for conformity bias (Pizzera, 2012).

Gymnastics judges must be able to appropriately identify, differentiate between, classify, and analyze a variety of skills in a relatively short period of time, such as joint angles or any errors made in movement or form (Pizzera, 2012). For this reason, judges for more advanced levels of competition serve on one of two different panels, in which each panel has a different objective. While one panel focuses on identifying skills in and discerning how difficult the routine should be classified as, the other panel focuses on more general errors in skill execution or in artistry (Pizzera, 2012). According to Alexandra Pizzera's (2012) study, gymnastics judges did seem to have better judging abilities with prior motor experiences concerning the specific gymnastics skill that they were judging, but general motor experiences in gymnastics did not benefit judgment performance. Judges with specific motor experiences in the gymnastics skills that were being judged also were able to more accurately perceive specific angles that legs and arms were bent at, and whether the legs were in a parallel position (Pizzera, 2012). Overall, these study findings illustrate that judges' sensorimotor experiences seem to provide an additional level of expertise when it comes to precisely analyzing the rapid and complex movement patterns that are seen in gymnastic skills during the performance of routines (Pizzera, 2012). Since judging quality was in fact improved if judges had prior motor experiences with the gymnastics skills being observed, perhaps this could be a criterion for participation in the educational training programs for prospective judges. Further, in individuals without prior gymnastics experiences who are interested in judging, perhaps gymnastics lessons and courses could be offered in order to facilitate these relevant motor experiences. Similarly, retired gymnasts could be encouraged to become judges as a means of remaining active with the sport and as a way of sharing their expertise in a constructive manner that will benefit the judging quality of gymnastics routines during competitions (Pizzera, 2012).

Conclusion

"Acting in the world, interacting with objects and individuals in it, representing the world, perceiving it, categorizing it, and understanding its significance are perhaps simply different levels of the same relational link that exists between organisms and the local environments in which they operate, think, and live" (Garbarini & Adenzato, 2004, p. 105).

In recent years, embodied cognition has become more widely accepted as a holistic approach to understanding the complexities of cognitive processing. For instance, the mind is no longer solely considered as completely separate from the body and wholly understood according to internal logical representations and symbolic manipulations. Accordingly, Francesca Garbarini and Mauro Adenzato (2004) describe the mind as "no longer conceived of as a set of logical/abstract functions, but as a biological system rooted in bodily experience and interconnected with bodily action and interaction with other individuals. From this perspective, action and representation are no longer interpreted in terms of the classic physical–mental state dichotomy, but are closely interconnected" (p. 105). A number of

influential theorists that supported the embodied cognition perspective that were discussed in this paper, including James Gibson, George Lakoff and Mark Johnson, Eleanor Rosch, Daniel Dennett, Maurice Merleau-Ponty, and William T. Powers.

Embodied cognition was investigated through a variety of perspectives, and was first examined from an evolutionary perspective, in which the structure and interactions made between the physical body of our ancestors and the external world allowed for brain development in response to the body's actions and existing needs over time. This eventually led to the development of human cognitive abilities (Wilson, 2008). This embodied approach was then compared to that of the more traditional cognitive/computational perspectives, which emphasized the importance of logical processing and mental representations primarily formed in a symbolic manner (Cappuccio, 2015). Embodiment was also explored via the expression of emotions (Robinson, 2007) through music (Cox, 2016) and through dance (Snowber, 2012). Further, relationships concerning embodiment in athletic activities (Cappuccio, 2015), such as in dance (Chirazi, 2021; Snowber, 2012), the martial arts (Kimmel & Rogler, 2018), and gymnastics (Daroglou, 2011; Luis del Campo & Espada Gracia, 2018; Marsh et al., 2006; Pizzera, 2012), in addition to musical activities (Chirazi, 2021; Cox, 2016; Schiavio et al., 2019), were discussed. Differences between choreographed movements and improvised movements, particularly in music and in dance, were explored, in addition to the importance of gestures as a form of creative expression (Barrero González, 2019; Cox, 2016; Snowber, 2012). Finally, self-belief, self-efficacy, and self-concept were discussed in relation to gymnastics (Cappuccio, 2015; Daroglou, 2011; Weiss et al., 1989), and the benefits to attaining high levels of each, along with establishing various psychological coping strategies (Pizzera, 2012) were explored (Daroglou, 2011; Marsh et al., 2006; Weiss et al., 1989). Further, in the context of gymnastics, judging abilities and how they were influenced by prior experiences were also investigated, and Pizzera's (2012) findings indicated that specific motor experiences concerning the skills being judged did enhance abilities to gauge the minor intricacies and detect errors in a gymnast's performed routine.

All in all, embodied cognition encompasses our physical/bodily interactions with the environment, and it allows us to more advantageously perceive, remember, contemplate, and act on complex information that is presented to us, helping to explain instances in which we are not conscious of our actions. For this reason, elite athletes and musicians have fully learned a skill when they no longer must be fully conscious as they prepare to perform the next motion or configuration in order to execute the skill successfully or find the next note in order to perform the song successfully. In the context of learning more generally, we utilize environmental resources and have developed technological advancements as a means of off-loading information from our heads to the external world for further examination and long-term storage (Dennett, 1996; Wilson, 2008). As such, embodiment arises in numerous aspects of our everyday lives. The countless activities and practices made possible by technological, social, cultural, and intellectual

advancements over time have allowed us to function at an advanced level in the way that we do, performing in impressive athletic endeavors, playing beautiful music in an individual and group setting, and developing extraordinary tools and technologies that allow us to succeed at tasks and activities that otherwise would not be possible.

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