Selective Engagement with Specific Invariants in the Perception of Art

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ABSTRACT
The perception of artifice or art is inextricably intertwined with the rich regularities manifest in the environment in which individuals are immersed. Taking my cue from James Gibson, I recast the problem of perception of works of art as part of a wider problem of possibilities for perceptual experience and selection of attention toward specific invariants in a populated environment, drawing upon examples from music, sketch comedy, and East Asian calligraphy. When a work of art is viewed not merely as a configuration of stimuli, but rather as something that makes available the information (in Gibson’s terminology) that lies open to further scrutiny, the range of possible discrimination is unlimited. At the same time, through selectively emphasizing specific invariants, a work of art offers the real possibility for active perceivers to discover for themselves what is important, which might otherwise remain unnoticed. Fundamental to theories of perception of artifice is the recognition that our modified environment is still indefinitely rich, in which individuals are provided with open-ended possibilities for tuning in on the specific regularities that are relevant to concerns at a particular time and place.

Prologue
In the 1970s, James Gibson published a series of related papers on perception of works of visual art in the journal Leonardo (Gibson, 1970, 1971, 1973, 1974, 1975, 1978a). He was primarily concerned with the puzzle of picture perception, with the nature of information that is available in an unchanging optic array. Among the papers was the paper entitled ‘Pickford and the failure of experimental esthetics’ (Gibson, 1975). In the paper, Gibson addressed the problems of so-called ‘experimental esthetics’—a special branch of psychophysics founded by Fechner (1876) that was followed up by experimental psychologists in the twentieth century. According to Pickford (1972, p. 4), Fechner advocated ‘the experimental investigation of judgements of preference for simple stimuli in order to build up from below those stimuli and combinations which would be used in complete works of art’. In terms of visual art, basic assumption has been that there is a patchwork of colored forms and corresponding sensations to begin with, to which value and meaning are attached by an observer (Gibson, 1975). Based
on this assumption, a number of experiments concerned with color or form have been conducted: Do certain combinations of colors appear more beautiful than others to novices or expert artists? Do certain lines or curves trigger particular feelings among Europeans, Africans, or Asians? Observers are instructed to rank the composition of colors and forms in order of preference or rate them on a scale comprised of adjectival opposites. But the results were never clear. Nothing decisive about perception of visual art has emerged from these experiments. 'In my opinion,' Gibson (1975, p. 320) concluded, 'a whole century of experimental esthetics has failed to discover what it hoped to discover and the enterprise should be abandoned. … It failed because it was based on a mistaken theory of perception, the assumption that perception is based on sensations.'

At the end of the same paper, Gibson (1975, p. 320) briefly hinted at an alternative approach to understanding the perceptual experience of a work of art:

‘A work of art is not a stimulus, nor a compound of stimuli, nor even a configuration of stimuli that is more than the sum of its parts. It provides information for perception—information that has been selected by an artist from the flowing sea of stimulus energy around us, and usually enhanced or emphasized by him. It educates our attention. It shows us how to look and listen. It points out what is important. It reveals meanings previously hidden.'

Here, Gibson’s use of the term information requires caution. Gibson’s notion of information has nothing to do with transmission of signals from a sender to a receiver, unlike the way the term has been used in communication theory. In Gibson’s (1979/2015) terminology, information consists of invariants in the flowing sea of energy around active perceivers that specify substances, surfaces, and events in the environment. In terms of vision, Gibson drew a clear distinction between (1) light as a stimulus that stimulates photoreceptors in the retina and (2) light as information for perception that can activate a perceptual system (Gibson, 1979/2015). The application of stimulus causes a response of the sensory mechanism, and the response is an effect. By contrast, the information available in the sea of energy around a perceiver does not cause perception but simply offers the opportunities for perception, and ‘perception may or may not occur in the presence of information’ (Gibson, 1979/2015, p. 50). Actual perceptual experience of a perceiver, as Gibson (1979/2015, p. 50) pointed out succinctly, ‘depends on the age of the perceiver, how well he has learned to perceive, and how strongly she is motivated to perceive.’

Gibson’s argument in this context echoes the contrast he made between sensation-based theories of perception and his own information-based theory of perception. Trying to understand how sensations are triggered by physical stimuli is one thing, but assuming those sensations are the basic elements of perception is quite another (Nonaka, 2024a). Regarding vision, while a sensation-based theory of perception may account for the correlation between light intensity and brightness, as well as wavelength and color, it cannot explain how we perceive meaningful surface layouts and events by means of light. ‘Perceivers are not aware of the dimensions of physics’ (Gibson, 1979/2015, p. 293). They are aware of the dimensions of the information in the flowing array of light, sound, and energy of other sorts that are relevant to their concerns.

Light, sound, and odor coming from sources in the environment becomes ambient in the medium (e.g. air) (Gibson, 1979/2015). Ambient energy is indefinitely rich in
what we call pattern and change (i.e. ambient energy array), whose invariant structure species the source in the substantial environment. This is what makes substances, surfaces, places, and the events of the environment potentially perceivable. Perception typically involves the possibility of further exploration (of scrutinizing, of looking and listening more carefully) whether or not the possibility is taken advantage of Gibson (1978b). The meaningful properties of substances, surfaces, places, and environmental events are specified by the invariants of the ambient energy array. Some of these properties are of particular concern to us, while others go unnoticed (Gibson & Gibson, 1955). In this respect, Gibson did not distinguish between perceiving the natural environment and perceiving events and layouts of surfaces altered by humans: ‘Two separate kinds of perception, ordinary perception, on the one hand, and esthetic perception, on the other, do not exist. There is only one kind of perception, the perception of the world with the meanings and values already in it’ (Gibson, 1975, p. 320).

Gibson’s rejection of the idea that esthetic perception is separate from ordinary perception followed from his ‘new’ description of the world of ecological reality that is not value-free from the outset.

In this article, I would like to follow up the approach Gibson hinted at. More specifically, I aim to recast the problem of perception of artificial layouts and events (such as works of art) as part of a wider problem of real possibilities for perceptual experience and selection of attention directed toward specific invariants in a populated environment, drawing upon examples from music, sketch comedy, and East Asian calligraphy.

**On modes of listening**

In a private correspondence dated August 22, 1970, with Norman Malcolm, a colleague and philosopher at Cornell University, Gibson made one of his rare remarks on the perception of music (Nonken, 2008, p. 288):

> I meant that ‘the same stimulus array’ will always afford (offer the same opportunities for) the same perceptual experience insofar as it carries the same variables of structural information (Gibson, 1966, p. 248).

In the case of your example, I would argue that structural sequence of sounds may in fact be music, 18th century music, Mozart, badly played Mozart, a sonata, etc. All of them are in the structure of the sounds. When a listener ‘hears’ one rather than another, he does not detect a difference in the structure for the different perception, he only abstracts different features of the available structure. I do not mean that he detects different structures in each case. Structure, in sound and light, is inexhaustibly rich.

In the letter, Gibson acknowledged that listeners can perceive the same auditory event differently, implicitly rejecting the idea that the same stimulus would cause the same perceptual effect or response. Instead, by taking the inexhaustibly rich structure of the sounds into account, Gibson argued that the same acoustic array would offer the same opportunities for perceptual experience to active listeners, even if individual listeners may focus on different features of the available sound structure at any given moment. This is based on the fundamental fact that ‘structure, in sound and light, is inexhaustibly rich’ even in artificial arrays like music. Gibson’s perspective, which emphasizes the abundance of information in a medium, providing the possibilities for various
experiences, contrasts sharply with the notion that diverse experiences are solely constructs of the mind. This point is developed at length in Nonaka (2020).

Quite independently from Gibson, in his book ‘Treatise on Musical Objects’ (Schaeffer, 1966/2017), Pierre Schaeffer, a composer known as the pioneer of musique concrète, explored extensively how the complex structure of sound affords diverse modes of listening tailored to the interests of individual listeners. ‘Take, …, an acoustician, a musician, and … a Native American from the Wild West. The same galloping horse will be heard by them in very different ways. Immediately, the acoustician will have an idea of how the physical signal is made up (frequency band, fading due to transmission, etc.); the musician will go spontaneously to the rhythmic groups; the Native American will immediately conclude that he is in danger of being attacked, by how many, and how far away’ (Schaeffer, 1966/2017, p. 88).

Rather than reducing the process of listening into sequence of causes and effects, Schaeffer took a step back to explore the various purposes for which the act of listening can serve. In ordinary listening, individuals often listen to the event, aiming to detect information about the source that has structured the acoustic array. This mode of listening itself functions on different levels: I listen to a car, find its location, notice it's approaching, detect an odd noise from the engine, and then seek information about its condition (Schaeffer, 1966/2017). Or, when I play a plucked string instrument like the bouzouki, the sound specifies the string-plucking events, the condition of my instrument, my location, and the movement of myself. In another mode of listening, individuals might direct their attention to encoded information present in the sound, such as speech or Morse code. For instance, the sound of phenomes are not solely perceived based on their acoustic similarities but rather as part of a broader system of opposition and contrast (Chion, 2016). Some features of speech sounds are crucial for identification, while others are not. The distinctive features of these sounds are defined in relation to the language system they are a part of Jakobson and Halle (1956). In yet another mode of listening, individuals may focus on the sound itself, rather than listening to it as an indication of something beyond the sound. Metaphorically speaking, a listener can ‘taste’ the sound, similar to tasting a wine, not to discern its origin, vintage, or grape variety, but rather to recognize its qualities and characteristics. Even in a recorded sound, Schaeffer (1966/2017, p. 82) stated: ‘there is always more to be heard; it is a wellspring of potentialities that never runs dry. Thus, every time a recorded sound is repeated, I listen to the same object … although I perceive different aspects in succession’.

In acknowledging the individual difference of listening experience, Schaeffer (1966/2017, p. 103) writes, ‘we are not thereby laying the emphasis on the subjectivity of the individual (which is apparent at the time of the training needed for effective practice) but on the objectivity of the objects scrutinized by particular experts’. What Schaeffer referred to as ‘the objectivity of the objects’ seems to be the regularities that are manifest in the sound, including the laws by which some features in the acoustic array specify some facts of the world that can be picked up by particular individuals.

In ‘Ways of Listening’ (2005), musicologist Eric Clarke further investigated how musical experiences could be attributed to patterns inherent in the sounds themselves. An illustrative example provided by Clarke (2005) involves a listener hearing someone tuning a violin. What are the invariants that allows a listener to distinguish ‘tuning a
violin’ from a ‘piece of music’? Clarke examines how the invariant features of sound specify objects or events across multiple levels:

there is the instrument (violin), presumably specified by invariants such as the timbre, pitch height, and attack characteristics, which also specify the mode of activation (bowing) of the instrument and thus help to signal both its identity and the presence of a human being. Then there is the particular kind of event (tuning the instrument) that is specified in the stimulus invariants just as the instrument itself is. In this case the invariants would include the irregular, nonmetrical rhythm of the bow strokes; the consistent sounding of only open strings (specified by their characteristic timbre) at intervals of approximately a perfect fifth, always in pairs sounded together; and the continuous pitch glides in just one of the two paired strings that bring the pitches nearer to, or further from, a perfect fifth. Changing any of these invariants has the potential to cause the sound to specify a quite different musical event: if the two pitches, for instance, both varied in a continuous gliding manner in perfect parallelism, the resulting sounds might be heard as specifying a person playing or practicing a passage of music of some kind (Clarke, 2005, pp. 44–45).

‘Tuning a violin’ is a socially established practice heard differently from a ‘piece of music’ within the cultural framework of Western concert music. Those who have learned to engage with music within such a community of practice can selectively attend to particular invariants, such as the interplay of rhythm irregularity, interval structure, and pitch glides, enabling them to distinguish between the two separate events (Clarke, 2005).

The acoustic array in the medium (i.e. air) is filled with invariants that specify things and events at various levels. This provides individuals with the opportunity to selectively focus on the subset of invariants that are relevant to their concerns. When the environment of a perceiver—artificial or natural—is construed as rich and meaningful to begin with, within which a purposeful agent can develop a ‘nose’ for its substructures in various ways (Rietveld, 2008), it becomes evident that understanding the perception of artificial arrays, including works of art, entails investigating two key aspects: firstly, the nature of rich regularities that exist in a populated environment—an environment shared with other people, and secondly, how an individual’s concerns are shaped within such an environment.

On silly walks

One of the rich regularities in a populated environment that is open to scrutiny is the behavior displayed by human individuals (Gibson, 1982). The hands, arms, head, face, shoulders, torso, and the facial surfaces of human individuals can squirm in a vast number of ways (Gibson, 1979). The extent to which we can distinguish the subtle properties of these squirming movements of the living surfaces of other human individuals is truly remarkable. Gibson (1979/2015, p. 126) once addressed this point as follows:

The richest and most elaborate affordances of the environment are provided by other animals and, for us, other people. These are, of course, detached objects with topologically closed surfaces, but they change the shape of their surfaces while yet retaining the same fundamental shape. They move from place to place, changing the postures of their bodies, ingesting and emitting certain substances, and doing all this spontaneously, initiating their own movements, which is to say that their movements are animate. These
bodies are subject to the laws of mechanics and yet not subject to the laws of mechanics, for they are not governed by these laws. They are so different from ordinary objects that infants learn almost immediately to distinguish them from plants and nonliving things.

Let us think about the process of learning to walk. As we all know, human babies are not born walking, and the way infants walk is quite different from how adults walk (Ingold, 1998). What, then, gives rise to the transformational invariants that shapes the manner of walking over the course of development? Previous studies on the process of gait initiation have demonstrated that ‘the sole possibility of generating gait movement from an upright posture … comes from a rupture in balance’ (Brenière et al., 1987, p. 71). Stated another way, due to the constraints of the laws of mechanics, the sole means of generating propulsive force from a stationary stance is through gravity, which pulls the body downward when balance is disturbed, causing it to fall. Consequently, when infants take their first steps, the challenge they encounter is how to control this ‘fall’ in a manner that allows them to propel forward by utilizing the pull of gravity (Brenière & Bril, 1998). When a stick held upright on the ground falls, it would be accelerating downward at landing. When Brenière and Bril (1998) looked into the infants during the first few years of independent walking, this is exactly what they observed. When young infants walk, the center of mass is accelerating downwards at foot contact. But around four years after children start walking independently, their body’s center of mass starts decelerating upon foot contact, allowing for a soft landing, much like how adults routinely perform it without much conscious effort. As human individuals develop, their walking movement becomes attuned to the invariants of the terrestrial environment in a specific manner.

When a French social anthropologist Marcel Mauss fell ill in New York, he experienced what he described as ‘a kind of revelation’ (Mauss, 1973, p. 72) upon seeing the nurses walking by. Mauss pondered where he had previously observed girls walking in the same manner as his nurses. After contemplating for a while, he realized that it was at the cinema: The nurses were walking in the way American girls walked in American movies. Walking styles vary across different countries, and within certain societies, there are distinctions in the way men and women walk. Furthermore, the differences in walking manners between men and women vary among different communities. However, despite these differences, all forms of walking adhere to the same laws of mechanics, utilizing the pull of gravity. The experience at the New York hospital led Mauss to uncover another set of invariants that the manners of walking can be attuned to, beyond the laws of mechanics. Mauss (1973, p. 74) asserted, ‘Perhaps there is no natural way of walking’. In reality, the process of learning to walk cannot be isolated from learning to walk within one’s community. This is because learning to walk always takes place in an environment where other people are present, whose structure has been selected and modified by them (Nonaka, 2022).

Two points stand out in Mauss’s discussion. Firstly, there’s a focus on understanding the regularities within a populated environment, beyond just those of the terrestrial environment. In a populated environment, people are not only part of the environment but also perceivers of the environment (Gibson, 1982). Each person perceives other perceivers, and also perceives what others perceive. Consequently, each person is exposed to their shared environment in a specific manner, shaped by the unique
concerns of their community. Secondly, learning of affordances of things (like learning to walk effectively on the ground) differs from learning about normative concerns inherent in a shared environment. When one learns about the affordances of things, one is learning about properties of things with respect to one’s own actions. When one learns about the concerns manifest in the coordinated behavior of a community of individuals, one is learning about properties of one’s own actions and perceptions with respect to the awareness and activities of others in the shared environment (Reed, 1993).

The famous comedy sketch ‘Ministry of Silly Walks’ by the British comedy group Monty Python, which presented a range of absurd walking styles, also unveils the hidden regularities within a populated environment that would otherwise remain unnoticed. Upon observing individuals walking in various unconventional manners in the sketch (Figure 1), viewers would promptly burst into laughter. What is it about certain styles of walking that appear absurd and prompt viewers to laugh at them without much thought? Why are some walking styles funny while others are not? The sketch by Monty Python highlights how sensitive we are to walking styles that deviate from the implicit range of variation considered proper. It also helps us recognize the plain fact that there is no explicit model of the proper way of walking readily available in the environment for those learning to walk to imitate or consult. In our daily lives, what we observe is everyone walking in somewhat distinct manners, with no two people walking exactly alike. The central concern here is understanding what leads to the collective alignment of attention and behavior within a community toward specific subtleties of invariants in the intricate movements of living surfaces in a populated environment (c.f., Nonaka et al., 2024). In the subsequent sections, we will explore how we learn to selectively care about subtle regularities manifest in a populated environment, drawing on the example of attention toward specific invariants in an unchanging optic array.

**Figure 1.** An example of silly walk in Monty Python’s ‘Ministry of Silly Walks’. Courtesy of Jazeen Hollings.
Invariants in a frozen array that specify movement

In visual perception, among the basic distinctions that we learn to focus on is the distinction between the properties of a surface and the properties of markings on a surface (Gibson, 1980). The properties of surfaces include its layout and change across multiple scales, that afford a variety of encounters by animals including humans. Over the course of development, infants learn to selectively attend to specific affordances offered by them—to avoid a cliff (Gibson & Walk, 1960), cope with slopes (Adolph et al., 1993), grasp objects (von Hofsten & Rönnqvist, 1988), and distinguish the movements of living and non-living surfaces (Bertenthal et al., 1984).

On the other hand, in human environment, infants also learn to selectively focus their attention on the marks on a surface—the screen of smartphones, picture books, and televisions, which display the information about something other than the surface itself. The referential meanings of marks on a surface get apprehended by children in ways that differ from affordances of the surfaces. Since there is information in the optic array for both the surface and the marks on the surface, children learn to have a dual awareness, of the substantial surface itself and of the marks on the surface at the same time. Furthermore, the marks on a surface themselves have a wide variety of referential meanings which are different for pictures, drawings, plots, signs and letters, each involving distinct mode of visual attention directed at distinct invariants in the array.

Among the modes of visual attention toward the markings on a surface, the one involved in the art of handwriting presents a unique opportunity to describe the coordinated patterns of attention in a community of individuals. The peculiarity of this mode of visual attention is nowhere better illustrated than in the art of Chinese and Japanese calligraphy—the art of handwriting with brush and ink. The practice of East Asian calligraphy differs significantly from the European concept of calligraphy, which generally pertains to ornate penmanship or typographical effects (Billeter, 1990). When observing a piece of Chinese or Japanese calligraphy, the viewer doesn't merely see frozen forms or outlines of markings on the paper surface (Yen, 2005). Instead, when engaged with the artwork, the viewer would assume a distinct mode of visual attention, visually tracking and reexperiencing the rhythm with which the artist wrote each element of the character. In this way, the viewer would tune into the underlying dynamics of the movement that generated the marks, rather than solely focusing on the static form (Ingold, 2007). Despite the unchanging optic array made available to the viewer, experiencing a work of calligraphy involves sustained temporal engagement, offering a dynamic experience. For this reason, Jean François Billeter (1990, p. 11), a Swiss sinologist, wrote that ‘Chinese calligraphy is, in essence, an art of movement’, bearing a close resemblance to music. Similar to music, calligraphy demands uninterrupted execution without retracing, resulting in the surface trace serving as a vivid, high-fidelity record of the physical forces applied during the brushwork (Yen, 2005). The calligrapher moves from one element to the next, following a set sequence of strokes for each Chinese character, in accordance with the conventions shared within the community of practice. The brush captures every delicate motion of the calligrapher’s hand, offering viewers living in different times the chance to participate in the production process (Yen, 2005).
Certainly, when presented to an individual who has never been encouraged to attend to the movement-related features of an unchanging optic array, and who lacks experience in writing characters, a work of calligraphy cannot, of itself, compel the viewer to experience the art of movement (c.f., Reed, 1993). In what manner does the developmental process occur, wherein individuals begin to selectively focus on aspects of an unchanging visual display that are systematically linked to the manual movements that created the trace? Let me elaborate on this point, drawing on the concrete examples of Japanese children learning to write.

**Learning to dance at the millimeter scale**

In Japan, formal written language education begins with the focused instruction on mastering 46 *hiragana* letters (Figure 2a) during the initial 10 wk of primary school. *Hiragana*, a Japanese syllabary, originates from Chinese logograms (Sakamoto & Makita, 1973). Learning to write a *hiragana* letter entails tracing each of its elements in a specific sequence, much like learning Chinese characters, which is itself determined by a set of rules. Among various features, there are three distinct types of movements that conclude a stroke in *hiragana* (Figure 2b): (1) ‘hooked’, characterized by a brief stop followed by an abrupt reversal of movement at the end; (2) ‘sweep’, involving a fast, uninterrupted sweeping motion; and (3) ‘stop’, where the movement slows down leading to a complete stop at the end of the stroke. Despite variations in direction, each stroke forming a *hiragana* letters exhibits one of the three distinct types of movement mentioned above, whose contrast can help reduce ambiguities and improve legibility.

Nonaka (2017) documented the classroom interactions observed during the initial phase of *hiragana* learning, when children first encounter a shared classroom environment. In the observed classroom, two new *hiragana* letters were usually introduced per class hour. The learning process for a new *hiragana* letter always began with the teacher demonstrating its writing on the blackboard. Children were then encouraged to follow the teacher's strokes by coordinating the movements of their fingers in the air. Subsequently, the teacher would inquire about the distinctive features of the letter, usually in terms of its movement, and ask about words containing that letter. Then,

**Figure 2.** (a) A Japanese syllabary *hiragana*. (b) Three ways to end a stroke: ‘hooked’, ‘sweep’, and ‘stop’. 
the teacher would prompt the children, saying, ‘get your finger pencil ready’, once again encouraging them to raise their hands in the air. As the teacher traced the letter on the blackboard, children would carefully follow the rhythmic pattern of the teacher’s movements in the air with broad gestures of their arms and hands, as if they are learning particular dance steps from a dance instructor. As a result, both the teacher and the children in the class would partake in a shared rhythmic motor experience, as they wrote each stroke together—observing how the tip of a writing instrument moves across the writing surface, pausing, flowing, and stopping. While performing the movement, the teacher would provide instructions such as, ‘the first stroke, briefly stop at the end, and jump to the other direction’. It was found that 43% of the remarks made by the teacher during this activity focused on stroke order, while 31% were related to how to conclude each stroke (Nonaka, 2017). Typically, students would engage in ‘writing in the air’ twice for each new letter, then proceed to practice writing the letter individually in their notebooks before concluding the class.

Nonaka (2017) conducted a longitudinal study to track the development of movement involved in writing hiragana letters in the same children who attended the class. Over the three-month period of learning to write in a classroom environment, the patterns of handwriting movement in children underwent progressive transformations. At the outset, the children displayed varying patterns of handwriting movements: one participant’s movements stopped completely on the writing surface after each stroke, while another participant’s movements were consistently slow, small, and weak throughout each stroke. Yet, the subsequent changes in movement were not random; instead, they demonstrated some common transformational invariants in the directions toward which movement patterns evolved. Firstly, over the period of classroom learning of hiragana, there was a gradual differentiation in the velocity of the pen tip at the end of strokes, distinguishing strokes with different types of endings (Figure 3). Secondly, as classroom learning progressed, there was a discernible enhancement in the temporal consistency of each child’s stroke formation, evidenced by the increased mutual information observed between normalized resultant speeds of corresponding strokes within individual children. Notably, while movement styles may continue to exhibit variability across children, the temporal structure within each child’s writing movement exhibited greater uniformity (Nonaka, 2017).

In the Japanese classroom where observations were conducted, learning of the letters were not cut off from their motor foundations. The shape of each letter was seen as a consequence of dynamic movements, including how each stroke ended and transitioned to the following stroke. Each child was encouraged to attempt at moving one’s own body in a particular temporal sequence, which resulted in the common direction of development of handwriting movement by children. This development, in turn, demonstrated the gradual refinement of their attention focus on the critical features that differentiate one letter from another (c.f., Nonaka, 2024b).

The prioritization of movement may be a hallmark of writing systems influenced by the Chinese writing system. Sasaki’s (1987) series of experiments demonstrated that when Japanese individuals struggle to recall a Chinese character, they use hand movements until the gesture performs itself and brings back the forgotten form, similar to how we might recall a forgotten dance step. In fact, they are so used to ‘mock writing’ that if they encounter any uncertainty while writing a word, they trace the character
in the air or on their palm. This greatly helps to resolve the uncertainty (Sasaki, 1987).

*Hiragana* originating from Chinese characters, shares common characteristics in the set of strokes that form its letters. The process of learning letters, which incorporates rhythmic motor experiences, may be linked to the specific word recall strategies observed in Japanese individuals. This learning process might also be associated with the particular mode of visual attention toward a work of calligraphy, where an unchanging optic array affords a temporal experience. The example of handwriting demonstrates that it is in populated environments where we learn to pay attention to specific invariants that are crucial to the experience of art.

**Epilogue**

The perception of artificial surface layouts and events including works of art is inex- tricably intertwined with the rich regularities manifest in the environment in which developing individuals find themselves. When a work of art is viewed not merely as a configuration of stimuli, but rather as something that makes available the information (in Gibson's terminology) that lies open to further scrutiny, the range of possible discrimination is unlimited (c.f., Nonaka, 2019). At the same time, through selectively emphasizing specific invariants, a work of art offers the real possibility for active perceivers to discover for themselves what is important, which might otherwise remain unnoticed. Fundamental to theories of perception of works of art is the recognition

![Figure 3. Progressive differentiation of the pen-tip movement of one child between strokes with different endings composing *hiragana* letters. Black, dark-gray, and light-gray arrows on the right correspond to the ending velocities of pen-tip writing the elements with ‘hooked’, ‘stop’, and ‘sweep’ endings of *hiragana* letter shown in black, dark-gray, and light-gray on the left, respectively. The size and direction of arrows show the magnitude and direction of average velocity within a 50ms-window prior to lifting the pen. Overlaid arrows with the same color correspond to the multiple trials recorded at each week. Figure adapted from Nonaka (2017).](image-url)
that our modified environment is still indefinitely rich, in which individuals are
provided with open-ended possibilities for tuning in on the specific regularities that are
relevant to concerns at a particular time and place.

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