Paper: Is DNA expression generative art?

Topic: Design and professional art

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Abstract

Some authorities assert generative art is produced wholly or in part by stochastic algorithms executed autonomously or in part by digital computers. While this perspective is certainly plausible, a much broader perspective in this report emphasizes the human brain as computer, and then the spontaneous DNA expression of conceptual primitives. Gene expression is a chemical transcription of DNA coded information, and cognitive neuroscientists believe infants use this mechanism to reformulate innate perceptual information into conventional ordinary language image-schemas. A central assertion here is human perception implements a generative mechanism during infancy that utilizes DNA coded conceptual primitives to create visual knowledge. Moreover, shared human DNA information establishes wide appreciation for these images, a collective affinity for their preference. Survival functions of these images have been studied by anthropologists.

A conceptual primitive is genetic information linked to visual images instinctively recognized by humans. During early childhood, these conceptual primitives are triggered by specific environmental stimulation and spontaneously organized into conceptual hierarchies. Children socially interact with these images, which establish foundations for languages and literacies. Hierarchical expression of these images underlies children's early expressions from visual art through early writing literacy. This report reviews generation of visual images from conceptual primitives and their implications for visual arts and culture.

Conceptual primitives have phylogenetic origins that appear early in children's drawings and are directly related to eight images in nature and visual art. They are Circle, which symbolizes recursion and infinity, while Undulating line evokes movement, harmony, and direction. Jagged line, also called Zigzag, represents danger, threat, and harm. Spiral is one of the oldest images to assert movement but toward change and advancement. Other key images are Cells, which present stability and position, as well as Floral pattern, Sun burst, and Upright. These images are examined in this presentation in children's drawings, Western paintings, and popular culture.

Cell structure

Spiral

Undulating line

Circles

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Is DNA expression generative art?

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Premise

Philosophical discussions about creative introspection and artistic expression typically emphasize a mystic, magical process that originates in the human imagination [1]. Western literature is full of commentaries on the creative power of imagination [2], and museums thrive on presenting products of this imagination. More broadly, imagination is now recognized as the central generator of scientific knowledge. Coherence and rationality of knowledge is grounded on human experience and imagination

This paper presents an alternative, less mysterious, view asserting that much Western art includes primitive structures originating in human DNA. Creative imagination and introspection certainly have a central role in human creativity, but artistic production is also saturated with special insights derived from subtle genetic influences. In other words, gene regulation during visual art making underlies much more history of Western arts than is commonly understood. The creative processes of imagination from this perspective are to an important extent generated by DNA coding. Likewise, originality of art making is recognized as intertwined with evolution and natural selection. Therefore, a goal of this commentary is to address the title, Is DNA expression generative Art?"

In support of this idea, following sections first present a group of image templates identified in Nature that also appear in history of visual arts. A claim is made here that they have acquired unusual status during human evolution, and artists for centuries have perceptively integrated them into artworks. Furthermore, these image templates function as visual attractors because of their shared genetic origin, which contribute to the enormous appeal of visual art.

To increase an appreciation for image templates, they are linked here to conceptual primitives in cognition, as well as graphic structures in children's drawings. Their close relations with other mental entities that are usually associated with language development and early literacy provide support for their developmental origins. Evidence is then presented of their evolutionary function in drawings from Palaeolithic archives.

The final goal of this report is to consider the mediating influence of DNA on the sensitivity to image templates. Gene regulation is a mechanism that describes a complex interaction between chromosomes and environment, which do *not* follow Mendelian laws of genetics yet influence behaviour and diseases. Under certain environmental conditions, these genes complete a complicated chain of chemical transformations generating cell products and interest here is in their contribution to producing image templates.

1. Introduction

A hypothesis in this report is certain human chromosome genes are sensitive to primitive image schemas that Western artists integrate into visual art. These primitives differ from the aesthetic primitives related to elementary design [3]. Professional art training emphasizes composition design primitives such as color, form, spatial organization, motion or movement, and depth. However, training does not typically capture the less explicit primitives that are central to this report. Artists integrate the aesthetic primitives presented here into the thematic and affective effectiveness of an artwork, which may contribute to compositional integrity. Consistent with the view of this report, Dissanayake [4] referred to aesthetic primitives as "ingredients", "primitives are not art, but *ingredients* of art (p. 10)."

Like images in Nature, aesthetic primitives form highly predictable patterns distinguished by symmetries, hierarchies, spirals, waves, and cracks. Their regularity has led to mathematical models [5], as well as claims of universalism. However, unlike common appearances in Nature, which are widely acknowledged, schematic primitives in culture and art are less frequently recognized. Schematic primitives evoke reactions to paintings, architecture, and sculpture without provoking recognition because their appeal is at an instinctive, affective level. However, their pervasiveness on systematic inspection in paintings and artefacts is difficult to deny. Some speculation suggests aesthetic primitives are coded in human DNA and are products of natural selection and evolution.

The influence of heredity and DNA in particular, on human behaviour is a contentious topic in contemporary social science research. Genetic determinants of fixed human characteristics are widely accepted such as eye or hair color. But many aspects of human physical and emotional function are also directly affected by DNA, and they are governed by more complicated hereditary mechanisms called gene regulation. For example, feature detectors are innate neuron structures that extract physical cues from perceived objects and influence vision perception [6]. Feature detectors range in sophistication from general perceptual sensitivity to very simple stimulation such as colors and shapes, but other feature detectors respond to physical object properties such as edges and boundaries, as well as their motion. Genes regulating vision perception require light stimulation before "switching on" cells that will become light receptors [7]. This sensitivity has obvious implications for physical function and survival, and natural selection has benefited those organisms with it.

Linguists and cognitive scientists also emphasize the function of innate mental structures during language, literacy, and conceptual development [8]. Graphic primitives, conceptual primitives, image schemas, and mental models are cognition-related terms for describing innate mental structures. They first appear during infant preverbal development and are elaborated during early linguistic expression. They also appear in young children's drawings and, later, in early writing. In general, they are instrumental to developing facility with cultural sign systems.
A key assertion here is innately coded DNA information embody primitive images that are expressed in response to sensory stimulation. This interaction between innate

DNA and sensory conditions leads to formation of primitive schemas. This report is particularly interested in sensory conditions created by professional artists during art making.

Both neuron sensitivity and cognition described above evolved over millions of years in response to environmental variation and their current sophistication has established extraordinary foundations for human behavior. However, the role of genetics during this evolution remains controversial despite empirical demonstrations of highly organized behaviours dependent on predominantly genetic mechanisms. For example, honey bee hive organization displays very complex behaviour systems in some ways comparable to human activity and directly attributable to DNA coding [9]. This influence of genetics on human social organization, however, remains speculative [10, 11]

2.0 Jungian archetypes and universal images

The primitive images discussed here have ancient antecedents in Western philosophy. Plato in particular is widely recognized for asserting idealized universal forms and human sensitivity to primitive images of them in ordinary experience [12]. In 18th century philosophy, Kant [13] emphasized the prominence of innate logical forms or universal categories on human knowledge. Transcendental schemata are produced to mediate relations between innate categories and sense impressions. These metaphysical foundations, however, have never gained wide approval among aesthetic philosophers. Contemporary visual arts discussions tend to emphasize cultural products uniquely expressed by idiosyncratic artists.

Drawing on Kant's a priori categories, Jung presented enormous support for innate, subconscious archetypes, which he asserted underlie personality development [14, 15]. He believed innate universal symbols are genetically expressed during human development, and he characterized their manifestation with distinct personality types. The Hero. The Warrior, and The Regular Guy among many others are Jungian personality types derived from the potentialities of innate mythic archetypes and shaped by environment.

Jungian archetypes and universal symbols are from a collective unconscious of instincts and myths inherited from ancestors. Among many presented symbols, Jung's Mandala received substantial attention and was studied in several cultures [14].

Jung's archetypes gained substantial influence over psychological thinking in the 20th century and became central to the practice of analytical psychanalysis, which remains an important perspective on human psychology. Jung's assertion that archetypes are genetically transmitted is a landmark in the study of personality by bringing attention to transgenerational factors that influence development. While his insights into a collective unconscious tended to shroud his perspective in mystery, they gain new meaning in the contemporary context of DNA coding and epigenetics.

2.1 Universal images

Jungian psychology has stimulated many studies into archetypes, and Borgognoni Vimercati, an Italian restoration artist, undertook an ambitious historical investigation of archetypes in Western art. Her idea was a class of archetypal images are manipulated by professional artists in paintings and are instinctively recognized because they are coded in DNA [16, 17, 18]. She described several properties of these images including appearances in both Nature and history of visual arts. An interesting elaboration of Jung's archetypes is their simultaneous appearance at several levels of scale in Nature, which she documented with examples. Also, reactions to her images are accompanied by a predictable affective response. Unlike Jung's archetypes, but they are independent of personality. She called them Universal Images (UIs).

Her UIs are listed below with corresponding affective associations:

- Upright = Power, authority, stability, domination, prominence
- Floral motif = serenity, harmony, comfort, sympathy, kindness
- Sunburst = warmth, happiness, joy, expansive
- Zigag line = Danger, unpredictability, harm, pain
- Wavy line = Peaceful, tranquility, calmimg, aimless
- Cells = security, network, community, collaboration,
- Spiral = dynamic action, movement, power, direction, energy
- Circle = Infinity, continuous, cyclical, certainty, inclusive, clarity
- Rainbow = Wonder and fantasy

Figure 1 presents a set of primitive schema templates representing Uis identified by Borgognini Vimercati. With exception of Jung's mandala, archetypes and UIs show little correspondence. Growing consensus among scholars is UIs represent aspects of human evolution related to survival and adaptation, in particular, stability, security, harmony, and danger [19] in contrast to Jung's assertion of personality motifs

In general, symbolic interpretation of UIs seems to elicit broad existential commentaries. For example, the Upright symbolizes dominant, rigid authority, while the Circle [19] points to mixed reactions of unity and stability, or could be interpreted as movement, infinity, cycle, and stability. The Undulating line [20] evokes harmonious movement and direction. Jagged line, also called a zigzag, represents danger, threat, harm, pain, and conflict. The Spiral [21, 22, 23] is a symbol of movement, change, and advancement. Cell structure presents stability, limits, definition, position, and social organization. Other UIs are Floral pattern and Sunburst, and ancient Greeks discussed the rainbow as an important natural image. Indeed, Iris was the Greek goddess of the rainbow.

> And for Plato, Iris, the vision of the rainbow, is the embodiment of wonder in domain of the visual. The rainbow is a natural phenomenon that not only strikes the eye with its beauty, calls for explanation as well. And yet, even when an explanation is at hand, and we understand how the rainbow is created, there remains a sense of wonder (p. 21) [24].

These images appear in art, nature, and science, across cultures, and have been found in children's drawing instrumentally linked to early literacy development. More specifically, UIs function as conceptual primitives that are transformed during early drawing into alphabet letters central to literacy development [25, 26]. Paleolithic studies show them appearing in prehistoric art.

Although inspired by Jung's archetypes, UIs differ significantly in their function during art making. Jung's archetypes were the product of inherited instincts interacting with environment, and their emergence defines personality types, while Vimercati's UIs are primitives integrated by artistis into paintings. In other words, Jung's archetypes were the outcome of latent images rather than instrumental to their production. UIs are manipulated during the production of art. In addition, Borgognoni Vimercati's emphasis on continuity across levels of scale in Nature establishes a much broad context for collective unconscious. Disperson of UIs across art and Nature also has significant implications for understanding their phylogentic origins.

2.2 Appearance in Nature

UIs in Nature occur spontaneously but predictably, yet are unique events. A defining characteristic of UIs is their representation of foundational structures. They are Nature's building blocks. Figure 2 presents UIs in Nature and across levels of scale. A primitive schema template appears at far left, then iterations are presented across Figure 2.

2.3 Appearance in Classical Greek, Italian, and Contemporary Western art

Artists have long manipulated primitives such as color to elicit affective reactions. Kandinsky [27] wrote extensively about color and emotion and emphasized their spiritual aspects. Contemporary artists, however, refer to aesthetic primitives in more restricted terms such as lines, shapes and forms during image composition, which is consistent with a formal treatment during professional arts training. Some commentators are expanding this idea of primitives into neurological and psycho-sensory functioning [4], which encourages consideration of biological and artistic interactions. However, beyond generic compositional training, the function of image primitives during art making is not well understood.

A common misconception about UIs is artists "hide" them in visual art. On the contrary, in traditional Western paintings, artists carefully blend UIs into an image, while in contemporary art, artists simply "stick" them on an image anywhere convenient. Always, affective properties of UIs are consistent or complimentary to an artwork theme and typically move an artistic narrative it in that direction. Figure 3 presents UIs in Classical Greek art, which provides amply examples of spirals, undulating and zigzag lines, as well as uprights (columns) and cell patterns. Figure 4 presents examples of UIs in Italian paintings, where undulating lines expressed in draping are widely prevalent. Figure 5 presents UIs in Contemporary Western art, which is a striking contrast because image content is defined by only a particular UI. Figure 6 presents a composition of UIs upright, circle, and undulating line by Monet.

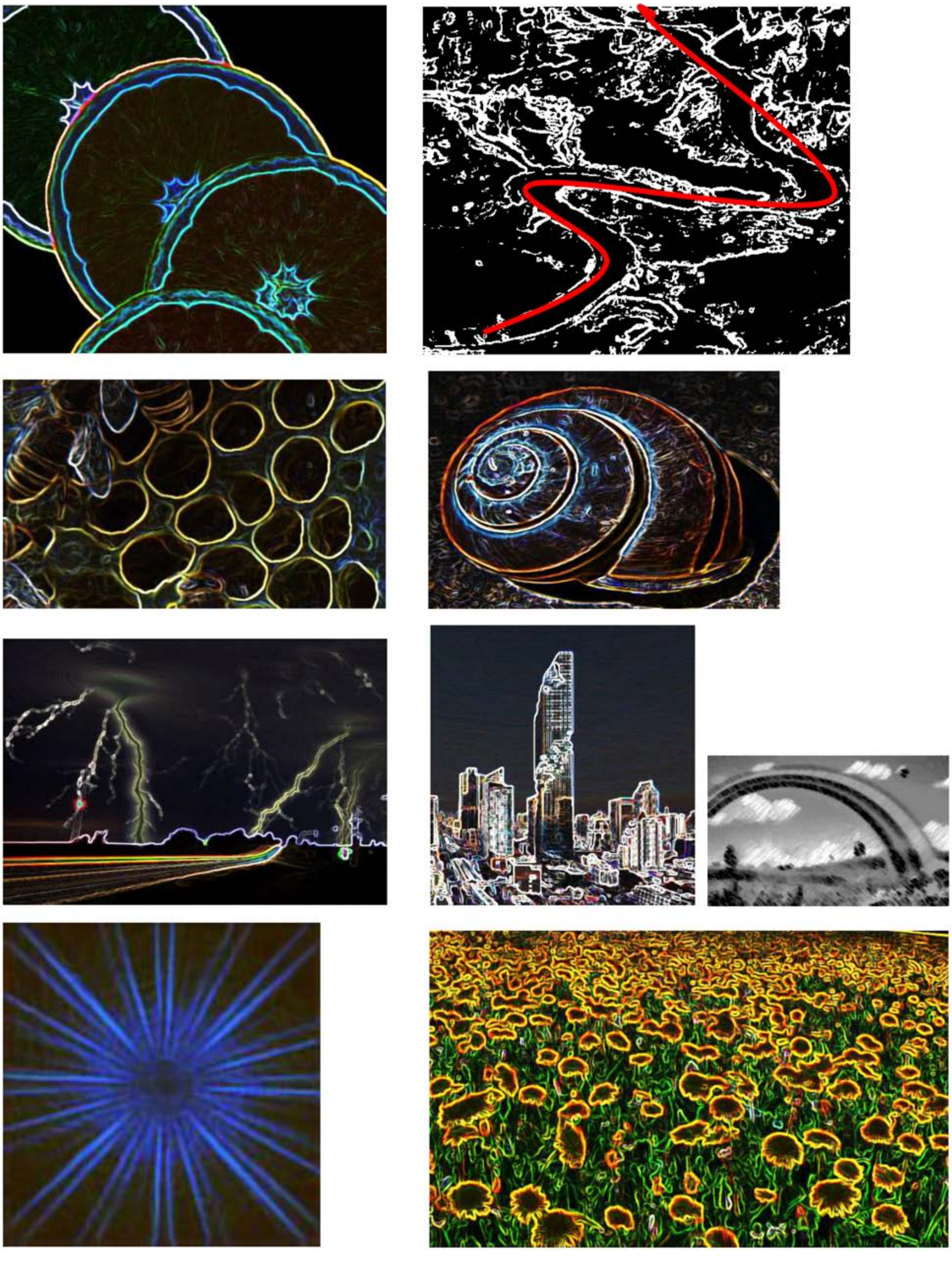

Figure 1. UIs generic template

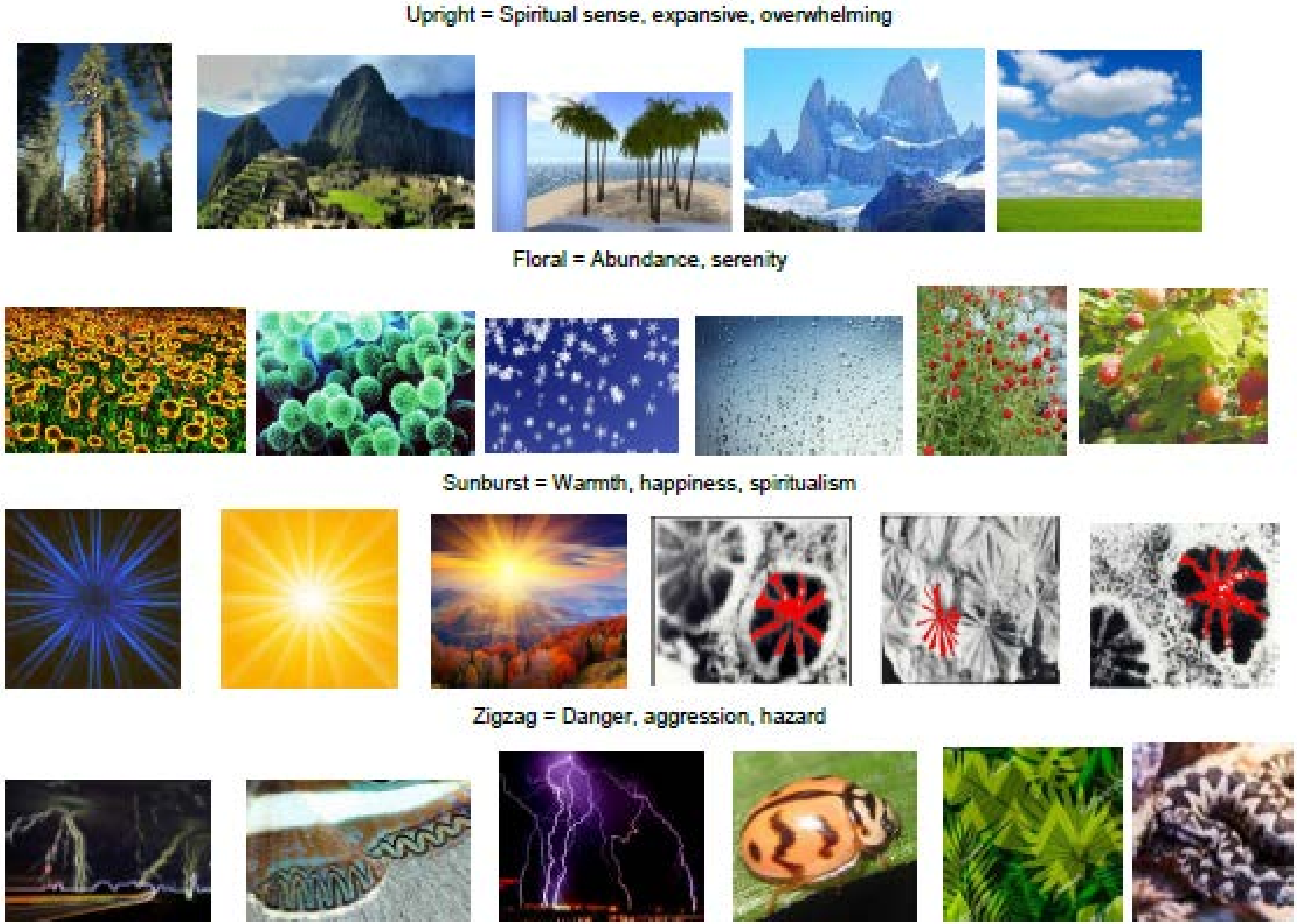

Figure 2. UIs in Nature

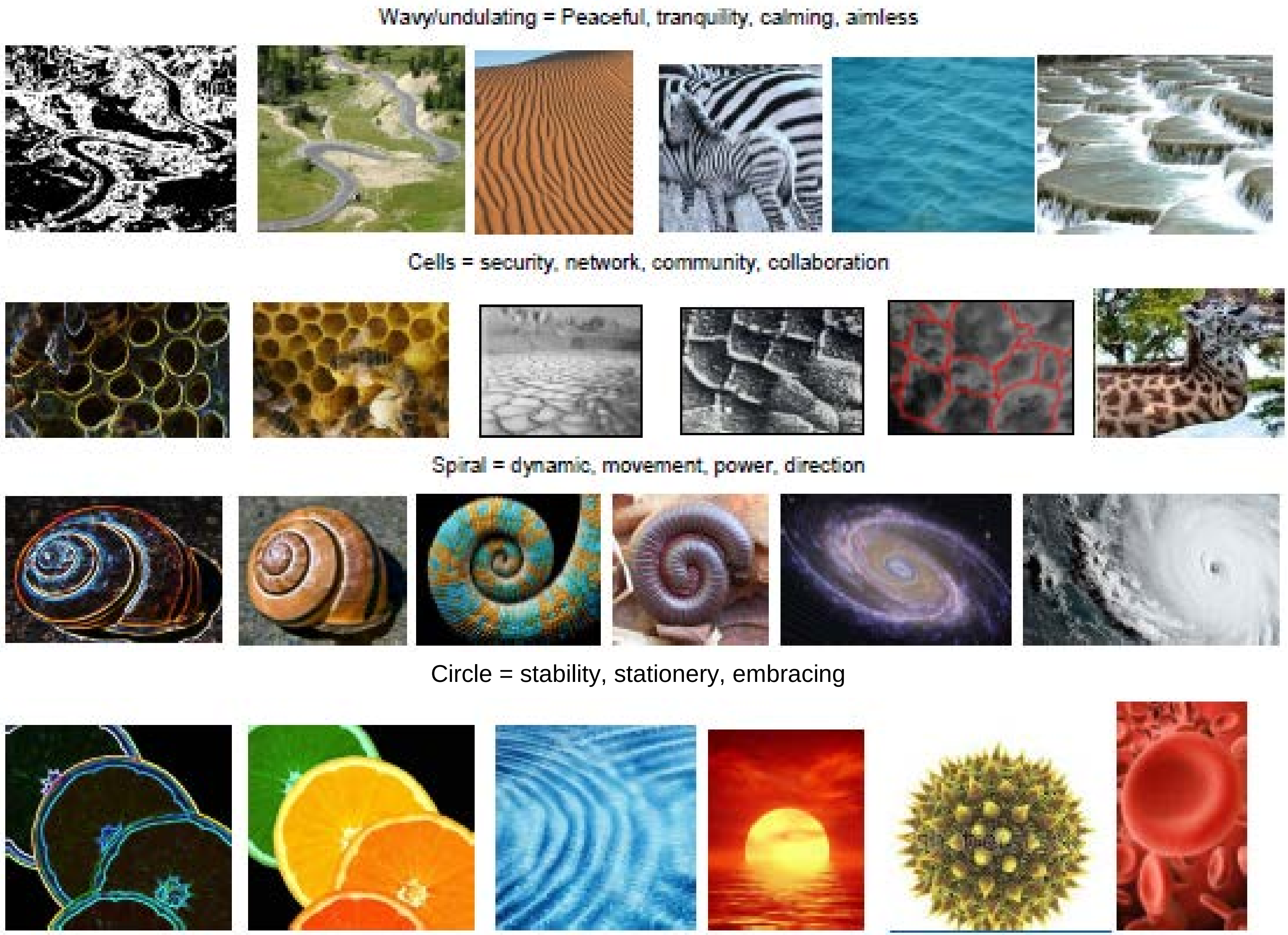

Figure 2. UIs in Nature (continued)

Figure 3. UIs in classical Greek art: Zigzag, spiral, upright, undulating line, cells, and circle

Figure 4. UIs in Italian paintings

Cristóbal de Villalpando, 17th century

Athena Scorning the Advances of Hephaestus, Bordone, 16th century

Bernini, 17th century

Angel with the crown of thorns Bernini, 17th century

Figure 4.

UIs in Italian paintings (cont.)

Andy Goldsworthy, 1997

Nate Halley, Bursting, nd

Akimoto Art Museum

Anonymous, nd, **Geometric**

Trinity, 2003

Anonymous, Honeycomb, 2003

Figure 5. UIs in Contemporary art

Anonymous nd

Rhythmic curves, Anonymous, nd

Spring splendour, nd

Figure 5. UIs in Contemporary art (continued)

C. Monet, 1874

Figure 6. Composition of UIs

3.0 Primitives in early literacy, child drawings, and Paleolithic art

Prior sections presented a set of UIs purported to appear throughout Nature and in Western art, yet they differ significantly from innate psychological archetypes. Following sections consider broader relations of UIs to innate conceptual entities in early literacy and children's drawings. Their appearance is also noted in Paleolithic anthropological archives.
At first blush, the assertion of UIs in visual arts at any level of human development seems unlikely. What possible function could they fulfil during human evolution? How would they differ from other conceptual entities? How could these images be transmitted across generations? Yet, a central fact is art depends on a cultural environment in which art makers exercise their talents over time. This issue becomes especially relevant if artists extract patterns and images from experience over millions of years. Any contributions of art making to human survival or fitness could be preserved in DNA, which gives new meaning to Jung's idea of collective unconscious.

3.1 Relations to linguistics

A question of innate mental structures first appears in linguistics in relation to language. Chomsky [28] strongly supported innate conceptual primitives dependent on environmental context, which appears in following quote:

> "Children display . . . from virtually their first words . . . they bring to bear thousands of rich and <u>articulate</u> concepts when they play, invent, and speak to and understand each other. They seem to know much more than they have been taught—or even could be taught. Such knowledge, therefore, must be innate in some sense. To say it is innate . . . is only to say that it is produced by the child's system of concept generation and combination, in accordance with the system's courses of biological and physical development, upon their exposure to certain kinds of environmental input." [28]

The idea here that children are endowed with a primitive structural grammar format that is stimulated by local environment and shaped by cultural conventions is central to this report. This innate generative grammar corresponds to the underlying primitive images in visual art.

> Chomsky argued that it [language] is incited by social <u>context</u> and discourse context but essentially uncaused—enabled by a distinct set of innate principles but innovative, or "creative. [29]

Following sections review a probabilistic model for generating images from primitives. Finally, gene expression is considered as a plausible model for human sensitivity to image primitives in visual arts.

3.2 Image schemas, graphic schemas, and conceptual primitives in literacy development

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Early literacy is a complex process of youngsters establishing spatial orientation and much research suggests an inmate activation of primitive imagery. Early products of this action are the familiar incoherent, external expressions of infancy such as body movements, gestures, and babbling. These idiosyncratic expressions are substituted for discrete objects, which establish simple concepts -- first physical then non-physical concepts.

Among early innate actions is spatial orientation and spontaneous expressions may begin with random marks.

This early process of spontaneously implementing innate responses occurs in a hierarchy, spatial concepts precede abstract ones, and incoherent expression such as scribbling precedes conventional alphabet letters. Significantly, drawing precedes writing. A crucial transition is differentiating scribbles into shapes and forms, which substitute for objects and ideas. A scribble becomes an object, and an alphabet letter is an object. Through this iterative process, conceptual hierarchies are formed that lead to early literacy, genetic foundations ensure this process reoccurs with successive generations.

3.2.1 Perspectives on image, graphic, and primitive schemas

Johnson [30] originally proposed embodied mental models derived from personal experiences that pointed in the direction of self-constructed knowledge. Meaning and rationality, coherence and understanding are fundamentally derived from this interaction of mental model and experience.

> An image schema is a reoccurring dynamic pattern of our perceptual interactions and motor programs that give coherence and structure to our experience (p. xiv) [30]

The function of these models serves to capture everything that can be known about reality. They assert innate predilections or tendencies, which establish a framework for comparing conformity of spontaneous experiences. However, mental model construction depends critically on individual actions on encountered experience, and continuous integration of future perceptions and actions to defined structures. Stable, predictable relations that result are the basis for knowledge.

Contemporary empirical studies of early conceptual development are being conducted from several perspectives. In context of mental models, Mandler emphasizes function of spatially defined schematic images derived from basic cell sensitivity, which establishes foundations for iconic imagery [31, 32, 33, 34, 35]. Several schematic images related to concepts of animacy or movement, causality, agency or direction of causality, and containment are functional during infant development. These primitive perceptual structures are foundations for mental models. Figure 7 presents schematic images that appear during infant development.

More recently [36], Mandler has clarified the instrumental function of spatial and motion primitives during schema development, which leads to three kinds of cognitive structure and constitute building blocks of image schemas. "She proposed that the infant's repetitive patterns of noticing aspects of its own bodily movement in relation to objects moving in the environment --relationships among objects, space, and time -- are "distilled" or "condensed" into conceptual primitives [37]". This perspective is supported by empirical research showing an innate inclination among infants to recognize visual cues of motion that trigger animacy perception of adults [38]. Bodily self-propulsion, in particular, was the stimulation that triggered the perception. .

The developmental importance of schemas cannot be overemphasized; innate primitives expressed in embodied mental models define the growth of knowledge for children. They are instrumental to forming concepts and knowledge networks.

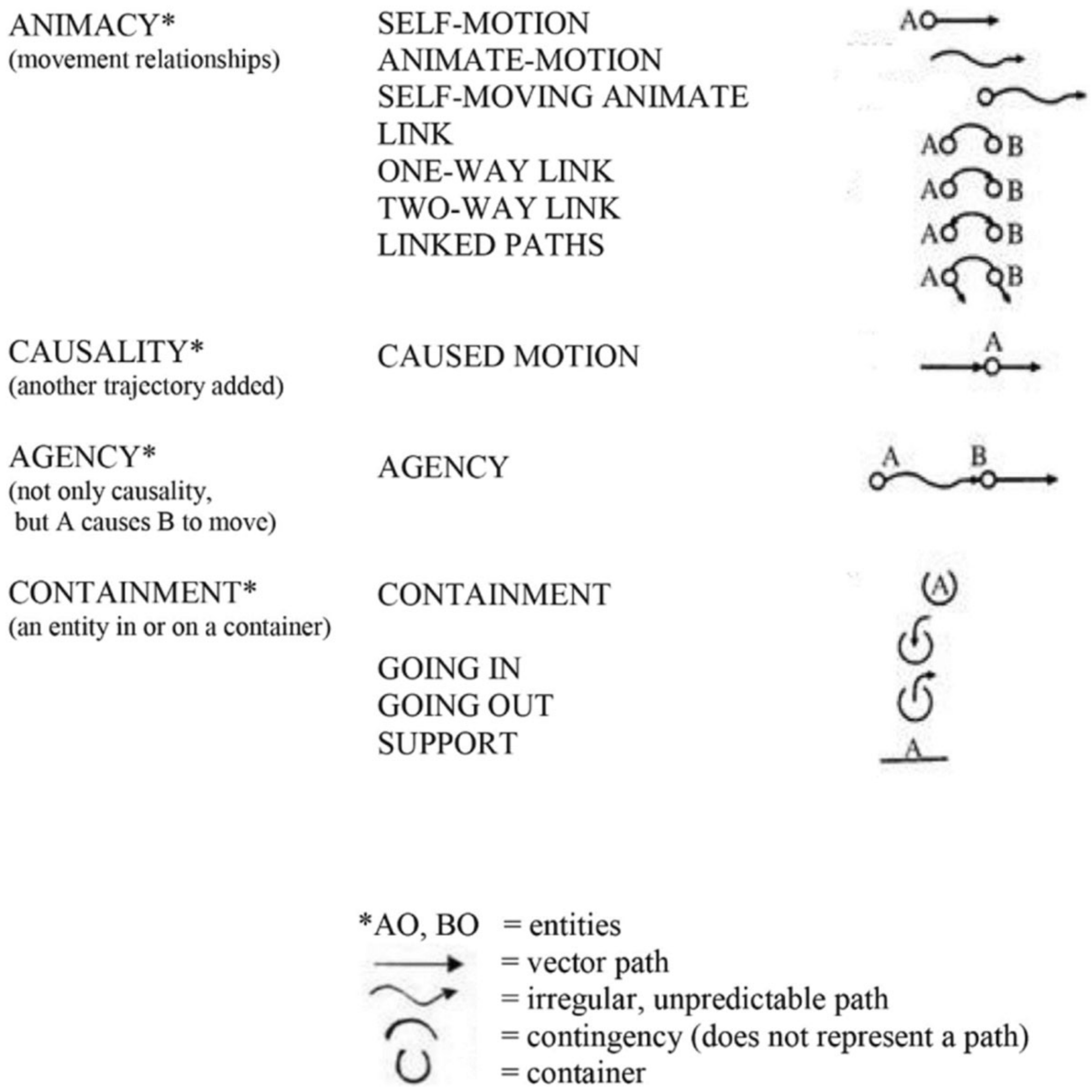


Figure 7. Mandler presents image schemas related to self-motion, animate motion, containment, and direction (going in vs going out) [31]. ”Accordng to Mandler, conceptual primitives form the foundations for visuospatial meanings that are instrumental later for relational thought and language (p. 5) [37]”.

The first image schemas are formed from innate spatial and motion primitives, providing infants with a way of understanding and remembering events without the burden of the infinite detail that events present (p. 1) [36].

> Babies are not Piaget’s sensorimotor creatures. A rich system of conceptual structures and cognitive habits is already in place before verbal activity begins. Language and culture necessarily build on this system. They boost it and change it, sometimes in dramatic ways, but they are also influenced by it (p.19) [36].

Spelke [39, 40] proposed innate primitive principles that implemented explicit rule structures for elaborating primitive forms. Carey [43, 44] emphasized a bootstrapping procedure where children begin with only innate primitive images and construct concepts scaffolding more complex concepts from simple ones. Experience elaborates these templates according to Quinan bootstrapping to establish complex concepts that conform to culture conventions. While predominantly linguistic, they also function artistically.

Empirical links between proto-drawing and conceptual schemas, not surprisingly, show strong correspondence during literacy development. This construction of literacy skill hierarchies are directly constructed from schematic primitives in drawings and this dynamic process is called emergent writing [25, 26, 45].

3.2.2 Examples from children's drawing

Some of the strongest evidence supporting cognitive primitives is found in preschool drawings, an environment explicitly organized to stimulate mental development. A long tradition of empirical studies have examined primitive imagery in children's drawings at least since Luquet in the 19th century, and those studies pointed to developmental relations between drawing and intelligence. Contemporary research now emphasizes very close developmental origins between drawing and early writing and drawing. In general, drawing and early writing literacy share a pathway that does not truly differentiate into independent, separate domains until children are about six years old [46]. then visual arts becomes a separate developmental strand and recognized as artistic aptitude and ability. Before the age of two years, children do not distinguish between drawing and writing. Therefore, artistic expression during early childhood could share important dynamics and genetic mechanisms with early literacy.

Visual stimulation during early childhood provokes innate, latent image inclinations, and children spontaneously embellish them during drawing to establish primitive schemas. They are transformed during their reappearance in early writing. Consequently, children's preschool drawings provide a convenient vantage for viewing the instrumental influence of primitives on conceptual development and early literacy.

Developmentally, children talk before they draw, and gestures and body motions appear before they talk. Moreover, drawing occurs in a socio-cultural context before they write. Children first scribble and gain control over drawing primitives, which they manipulate and transform during their assimilation of letter conventions of early writing. The dynamics of this process are a fascinating example of primitives in action [47] sometimes called emergent writing. Latent innate primitives stimulated by early learning present schematic templates, which children attempt to approximate in their early drawings. Children engage in much iteration involving successive efforts at scribbling in drawings to establish correspondence with schematic templates. Then hierarchical linkage approximate conventional alphabet and then early literacy. Manifest confusion and disorganization if not chaos observed by adults during this process of establishing a neurological substrate for conceptual foundations, which are extended and elaborated into multiple literacies throughout child and adulthood.

Primitive components, conceptual primitives appear early in children's drawings. Levin and Bus [41] referred to them in children's drawings as templates that establish an initial starting point for constructing more complex images. Mental templates impose order on unfamiliar perceptual experience, and children compare their drawing products with an a priori schema and improve this match with practice. They verify predictable relations in conformity with innate spatial and temporal principles**.**

Levin and Bus [41] in studies of child drawings proposed a graphic template that functions as an initial starting point for constructing more complex images. Perceptual experiences can be compared to a template to establish consistency and predictable relations in relations with spatial and temporal principles. Oakley [42] also emphasized function of templates.

In addition, empirical studies suggest these highly personalized templates are instrumental to children's symbolic conceptual development. Hierarchical development underlies children's progression from early visual art expressions through early writing literacy. In other words, these templates during early drawing establish foundations for a learning continuum that transform into complex conceptual structures. Figure 8 presents templates that children purportedly implement during early drawings and several UIs that spontaneously appear there have been circled. The broad range of UIs from circles to floral patterns appearing in early drawings was unexpected. In addition, children demonstrated a hierarchical progression, circles and spirals appear first for younger children, then undulating lines and rainbows appear for older children.

Figure 9 presents additional evidence of UIs in children's drawings from the perspective presented in Kellog's coding system [48]. Early scribbling demonstrates successive manipulations of circles, as well as spiral.

UIs also are functional during preverbal infant development. Yamagata [49, 50] conducted experiments that demonstrated children will select elaboration of a circle when given a choice between alternative primitives. One year old children understand the abstract function of a line in representation and will inscribe concrete details in a primitive circle. In other words, the circle facilitated graphic semantic expression. This capacity to abstract and express appears uniquely human. When chimpanzees were presented with primitive components, they could not complete the activity [51]. Figure 10 shows primitive components that were presented to children.

> They found that a drawn contour (DC) task, in which the child was given a circle for a facial contour, had facilitative effects with 1½–2½ year-olds as compared with a no drawn contour task (NC) (drawing on a sheet of paper). That is, in the DC task, 1½-year-olds drew something inside the contour indicative of primitive component parts (p. 131) [49].

Yamagata emphasizes below that infants do not have motor capacity to draw yet, they already have the abstract capacity to represent symbolic function with a primitive image.

> This fact seems to indicate that, on the basis of symbolic function, children at 1 year of age can understand that a line stands for something or extract the component parts, but they still have not learned how to draw. To learn to draw, it seems both acquisition of drawing method and motor development to produce controlled line drawings are indispensable (p. 139) [49].

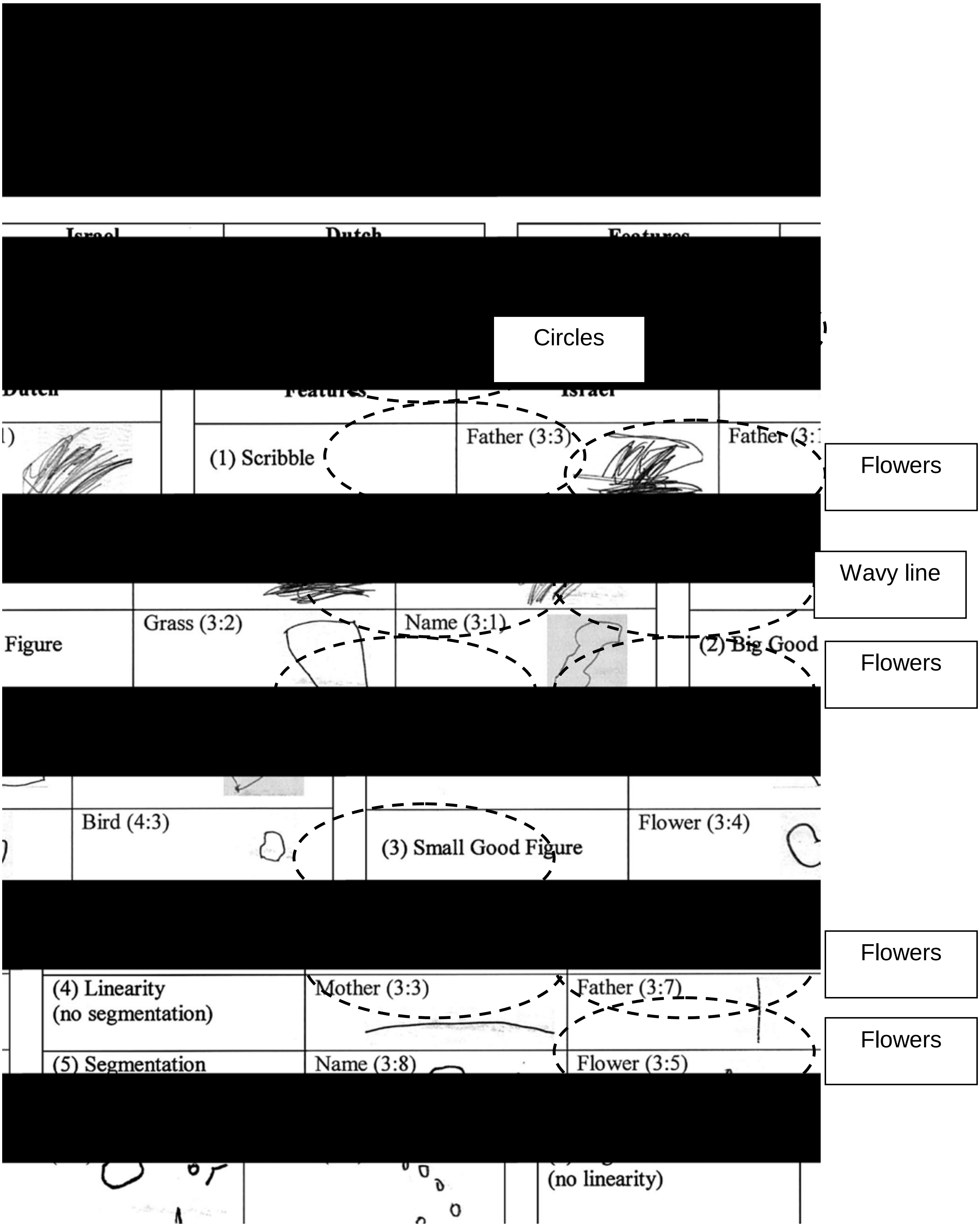
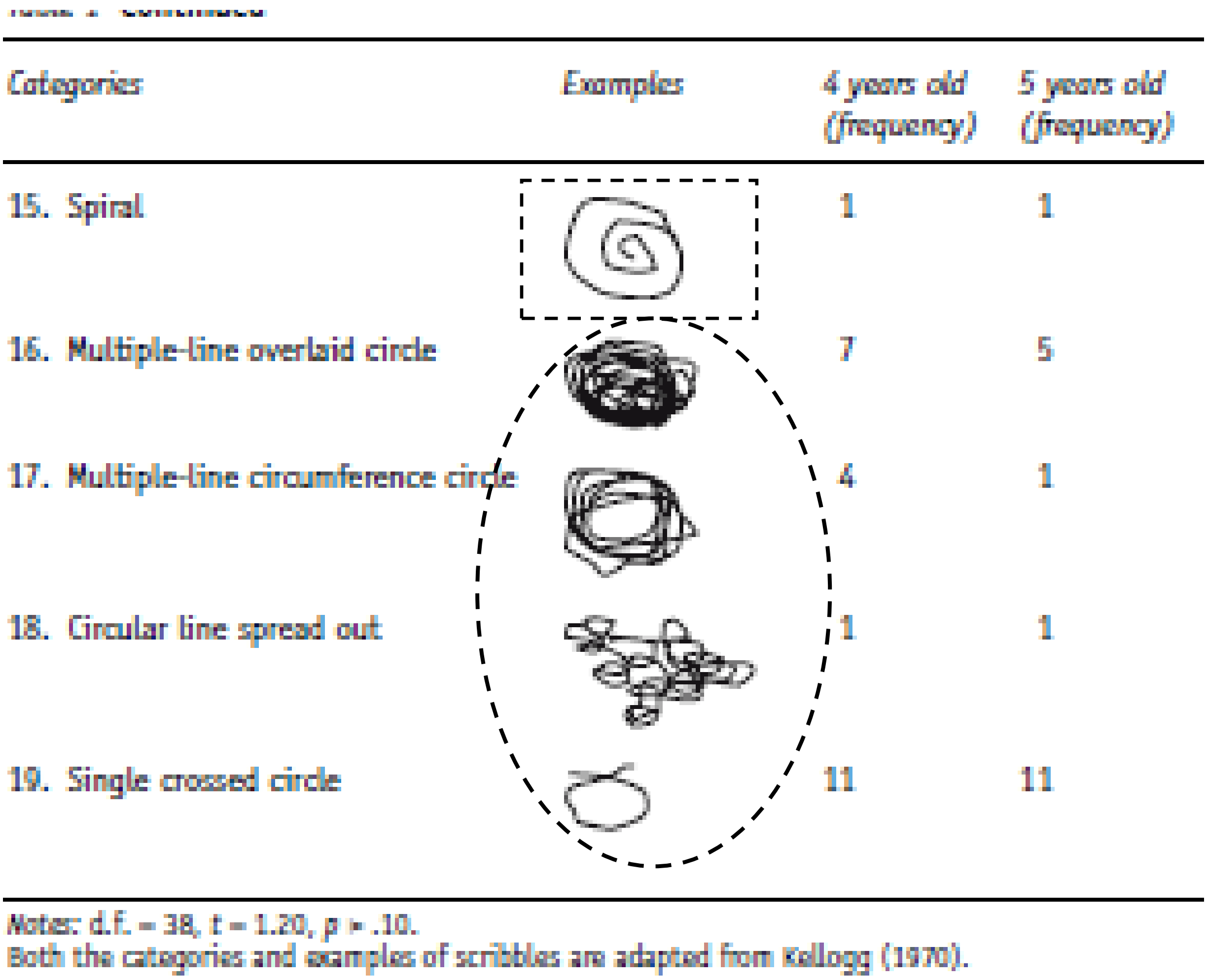


Figure 8. Children's drawing and early writing (p. 895) [41].



Categories	Examples	4 years old (frequency)	5 years old (frequency)
15. Spiral		1	1
16. Multiple-line overlaid circle		7	5
17. Multiple-line circumference circle		4	1
18. Circular line spread out		1	1
19. Single crossed circle		11	11

Notes: d.f. = 38, t = 1.20, p > .10.
Both the categories and examples of scribbles are adapted from Kellogg (1970).

Figure 9. Drawings show several manipulations of the circle, as well as an explicit spiral [48].

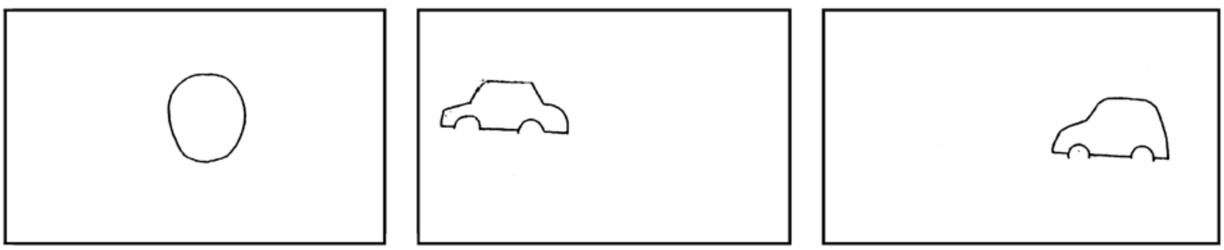


Figure 10. Primitive contours from Yamagata [49]. When presented these primitives, infants select the cirlcle for drawing.

3.2.3 Paleolithic origins of UIs

Much speculation has occurred about primitive images in Paleolithic art that have appeared across multiple geographical sites. Perspectives on neuro-development leading to these expressions, as well as their function in communication and ritual are prominent. Dissanayake in the quote below speculated on their preservation as symbolic states related to safety, order, and harmony. In general, image primitives in Paleolithic art tend to increase the weight of their collective importance, which suggests they arise out of the struggle for survival and adaption.

> Neuroscientist Derek Hodgson, for example, proposes that primitives may appeal to us aesthetically because, as inherent features of the brain, they come to connote what has been safe, secure, and understood; they provide order in the midst of disorder; and they convey a sense of pattern and harmony in the midst of the chaos and confusion of nature. Certainly features such as straight lines, edges, contours, geometric shapes, and contrast attract attention, give cognitive satisfaction, and can be used . . . by artists (p. 9) [4].

Figure 11 presents several image motifs from the Lower to Middle Paleolithic, they also appear across the Upper Paleolithic period. The correspondence between uprights, sunburst, zigzag, circle, floral pattern, rainbow, spiral, and undulating line is striking.

Hodgson also discussed the question of neuron sensitivity to specific lines and shapes [53]. In particular, "certain stable, invariant percepts may trigger recognition because . . . early visual areas are already pre-tuned to be responsive to particular stimulation. Their discrimination functionally contributes to survival in the world at large." Figure 12 demonstrates a similarity between rock carvings and abstracted linear motif of animals common in Paleolithic drawings.

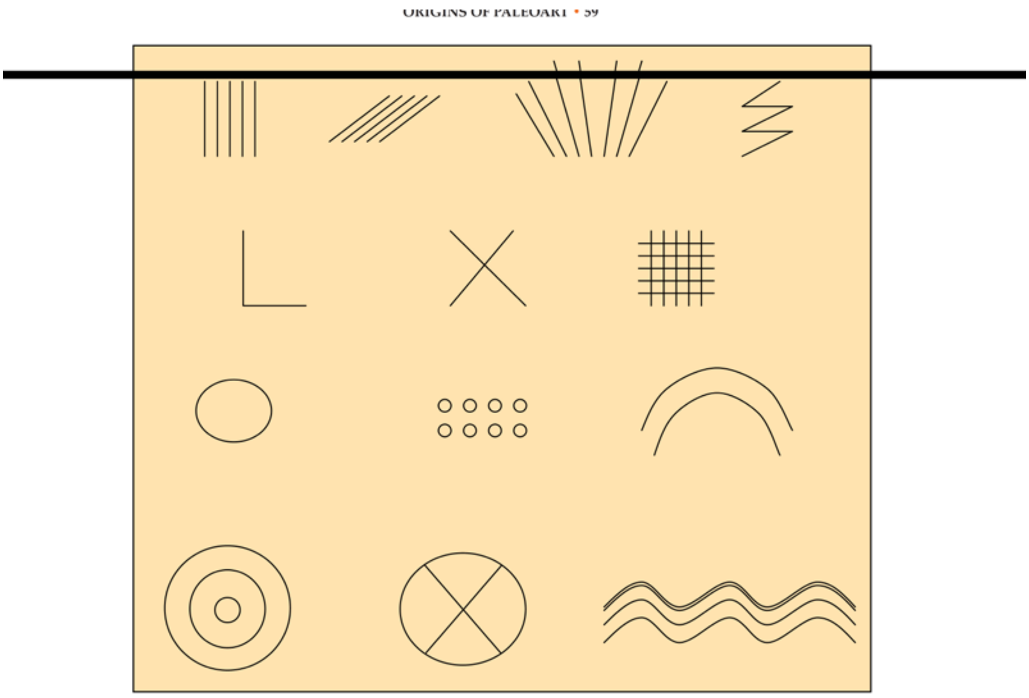


Figure 11. UIs in Paleolithic art. From Hodgson [52]

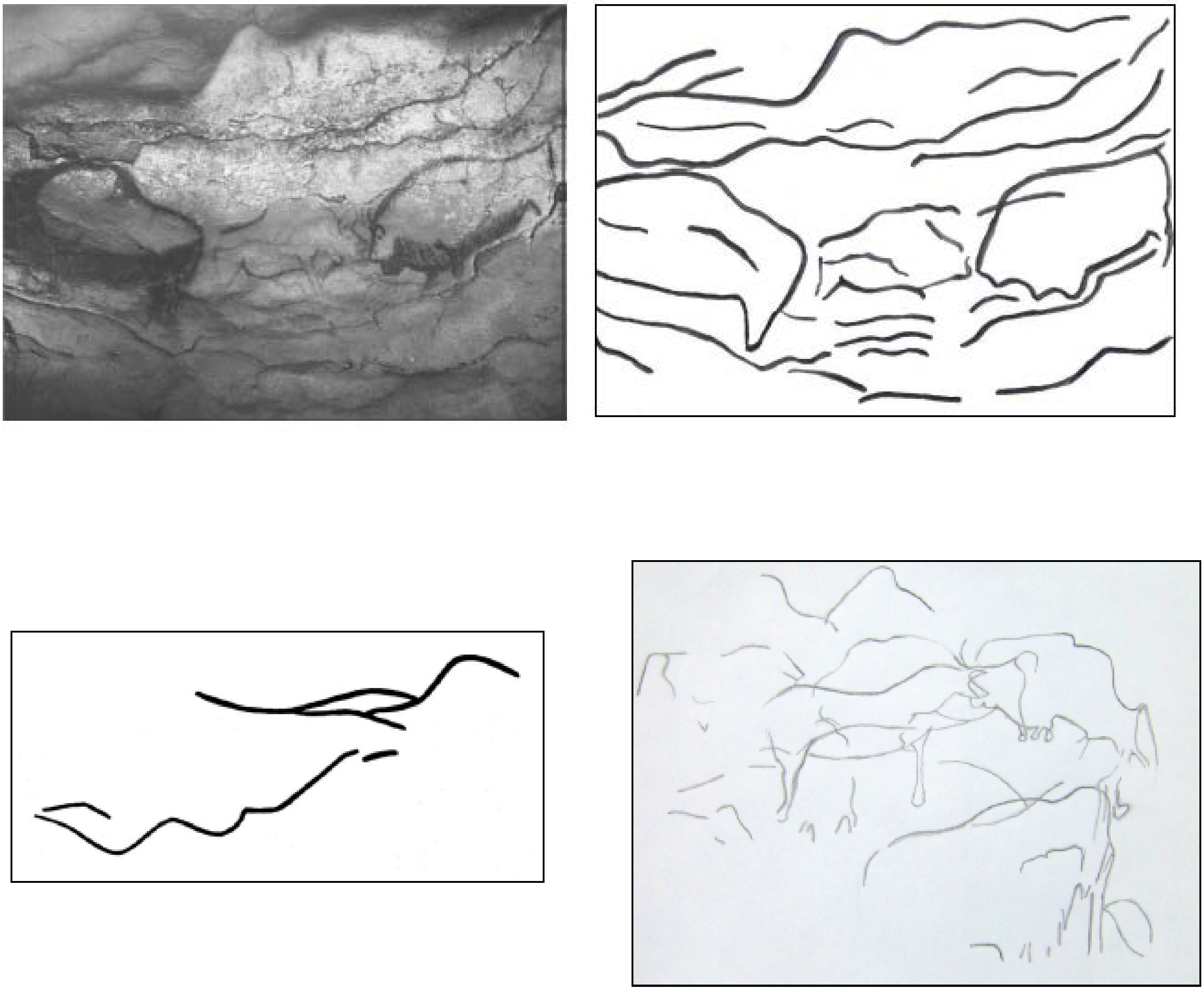


Figure 12. From Hodgson [53]

3.2.4 Probabilistic models for generative learning from primitives

The hypothesis of an innate generative grammar introduced by Chomsky and now the predominant in language and conceptual development is also relevant for describing the function of primitives in early drawing. Contemporary research is actively developing conceptual growth models with ideas about primitive components, reusing components, and extending conceptual hierarchies with probabilistic statistical methods. Lake et al. [54] present an approach to probabilistic generative models.

> As programs, rich concepts can be built “compositionally” from simpler primitives. Their probabilistic semantics handle noise and support creative generalizations in a procedural form that (unlike other probabilistic models) naturally captures the abstract “causal” structure of the real-world processes that produce examples of a category”(p. 1333) [54].

> In short, BPL can construct new programs by reusing the pieces of existing ones, capturing the causal and compositional properties of real-world generative processes operating on multiple scales (p. 1333) [54].
>
> By testing our classification tasks on infants who categorize visually before they begin drawing or scribbling (52), we can ask whether children learn to perceive characters more causally and compositionally based on their own proto-writing experience. Causal representations are prewired in our current BPL models, but they could conceivably be constructed through learning to learn at an even deeper level of model hierarchy (53) (p. 1337) [54].

Figure 13 shows a set of primitives that children implement during concept formation. An emphasis on line segments, circles, and curves are prominent among them.

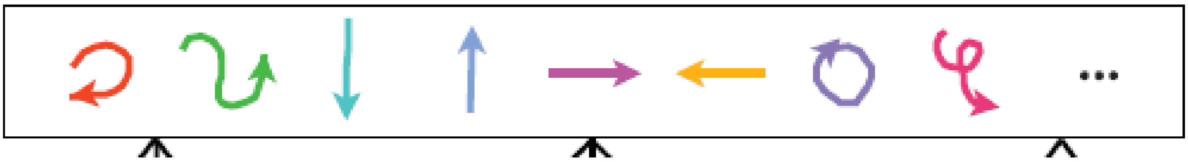


Figure 13. Primitives and operations in concept learning

4.0 What is DNA expression?

4.1 gene expression, and epigenetics

A classic example of Mendelian genetics is flower color transmission where genes provide instructions for a protein that defines the color of flower petals in successive generations. In general, human physical characteristics are stored in DNA, and over 18,000 human characteristics follow Mendelian genetic laws. However, many characteristics, about 5,000, have functional relations to a phenotype that is dependent on physical and social conditions independent of genetics. Some of these characteristics are related to disease and health. In other words, non-Mendelian genetics describe heritability that does not follow classical principles because transmission is mediated by more complicated cellular components that interact with the environment. A key mechanism in non-Mendelian genetics is gene expression, which is described below:

- Gene expression is a tightly regulated process that allows a cell to respond to changing external environment – within body chemical or external social conditions.
- Gene expression acts as both an on/off switch that controls vital protein production and also a volume control that increases or decreases amount of proteins.

Gene expression is a process of converting DNA coded instructions into products useful to the human body. These products are initially proteins, but DNA expression eventually may become a functional product such as an emotion or behavior.

This special area is called epigenetics, which describe changes in genes during imprinting and coding. In general, epigenetic gene expression responds to Internal (hormones, gender, affective states) and external (temperature, light, invariant perceptions) stimulation. The following quote from Lobo succinctly presents key issues surrounding gene expression.

> The expression of genes in an organism can be influenced by the environment, including the external world in which the organism is located or develops, as well as the organism's internal world, which includes such factors as its hormones and metabolism. One major internal environmental influence that affects gene expression is gender, as is the case with sex-influenced and sex-limited traits. Similarly, drugs, chemicals, temperature, and light are among the external environmental factors that can determine which genes are turned on and off, thereby influencing the way an organism develops and functions (p. 1) [55].

An important point here is these cell products become functional to the organism with important consequences for health and well-being including cognition and learning. An area not investigated yet is relations between conceptual entities and gene regulation. For example, during early literacy development gene expression is believed to produce idiosyncratic conceptual products that can be socially conditioned to approximate culturally-defined language and literacy conventions. In other an experience may trigger a primitive stored as DNA information, which is expressed in terms of UIs. Other experiences may present affective feelings of peace and tranquillity, which might trigger a wavy line. These primitives then become instrumental to constructing more complex schemas with explicit symbolic properties.

A general idea here is human reactions to visual images are mediated by gene activity. Normal affective reactions to visual images are mediated by gene activity. When children try to draw certain objects, gene expression leads to predictable emotional and behaviour reactions. Not surprisingly, some genes are probably sensitive to specific objects, while others function in networks. Moreover, DNA information is transmitted from generation to generation subject to natural selection. DNA information interacts with environmental and individual context. DNA can take various forms …instructions to “flip” on or off.

Gene regulation of artistic behaviour would contribute to understanding primitive images in visual arts. Indeed, on/off switching of genes during manifestation of schematic primitives in drawings is no less interesting than the instrumental function of these same primitives to abstract concept development that are assimilated into conventional language. Mimicking this process during early development is differentiation of art ability and early writing literacy.

4.1 Domain examples of mental structures during gene expression

Effects of gene expression on mental structures appear across a wide range of human characteristics and mental performance in particular. Researchers are identifying a growing body of innate cognitive structures that appear to be triggered by embodied physical experiences. For example, infant visual sensitivity to detect animacy or motion patterns is dependent on an a priori self-experience of self-propelled bodily motion. In other words, infants ’spontaneous efforts at self-propulsion trigger animacy perception among animals and humans. Velasco, [56] found comprehension follows perception, that is, the speaker’s bodily experience and environment trigger the linguistic expressions that carry conceptual meaning to language. Others [38, 57, 58] described an innate cognitive capacity that infers causal relations between two events or objects distinguishes humans from all other animals Munar, et al., [59] identified visual preference for curvature as a potential aesthetic primitive. Innate primitive mental structures have been identified for quantitative processing related to physics [37] while Dehaene,et al. [60] found core geometry knowledge among Amazon Indians. Rugani, et al. [61] hypothesized an innate structure related to number-space that maps observations to a mental number line. A similar structure was found among new-born chicks. Kersey et al. [62] also found innate number primitives are an abstract concept in humans.

Innate human predispositions are not restricted to physical observations. Detection of social stimuli were linked to a primitive at birth [63]. Liang [64] found gene expression related to a bee's role scouting for food sources versus nest sites. Changeux, [65] described brain levels of organisation from genes to consciousness.

5.0 Conclusion

In conclusion, imagination is nontrivial. The idea of gravity linking heaven and earth is profoundly imagined, an idea generated by Newton's creative insight. Likewise, the idea that a flash of static on a wool sweater is the same energy as a lightning bolt is pure imagination. The consequences of these creative insights and many others have changed the course of human evolution. The generation of ideas in the affairs of man is a central driver of practical knowledge and technological change, which is the undercurrent advancing civilization.

Therefore, it could be argued that most contemporary aesthetic philosophy is doomed because it fails to integrate artists and art making into human evolution. Art making sophistication parallels the advance of civilization but contemporary aesthetic philosophy tends to separate the art maker from this evolution. The artist is presumably transcendent and insulated from human change. The consequence is a philosophy of art generally estranged from the advances of civilization, and a sterile exercise in obscurity.

UIs have been identified across Nature at several scales, and they were found in visual art through the centuries, as well as in children's early drawings. A process was proposed concerning how UIs function in visual art, and speculations presented about the influence of DNA expression.

While the metaphysical discussion has pointed in the direction of an empirical aesthetic philosophy predominantly led by Plato and Kant, Jung's demonstration of archetypes in personality development is a practical milestone. Jung's archetypes, however, are a product of aesthetic primitives, a personality outcome after years of consolidation. This report has suggested that DNA information functions at an even more elemental level and has attempted to point in the direction of how they might look. A step forward now is to understand better how these primitives function as components in the human construction of knowledge.

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