Abstract patterns and representation: the re-cognition of geometric ornament

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Summary

Art historians, anthropologists and psychologists have long since been fascinated by the presence of surprisingly similar geometric patterns in the decorative traditions of different eras and cultures from around the world. During the nineteenth century these patterns were increasingly on display in international arts and crafts exhibitions and were described and analysed, for example, in encyclopaedias of ornament. From the moment the emergence and use of similar geometric patterns in different and remote cultures was recognized, scholars have tried to explain how such patterns could have developed independently in these different cultures.

Cognitive scientists have recently found empirical evidence, indicating that humans share the same cognitive resources which could be conditional for the recognition of certain formal aspects of visual artefacts. Cognitive psychologists working within the core knowledge paradigm assume that humans have innate systems allowing humans to make mental representations, for example, of objects, number and spatial relations.[1]

Given the assumption that these systems will develop in each human being, regardless of cultural background and education, core knowledge of geometry and number might be used to explain, at least partly, how it is possible that humans in different and remote cultures could have created such similar geometric patterns.

Still, core knowledge can only explain the *formal* conditions for making and recognizing geometric patterns. Anthropological and art historical studies, however, show that in many cultures geometric decorative patterns function as *representations*: an important aspect often neglected in cognitive research whereas the observation that geometric shapes and patterns are exactly applied in linguistic and symbolic contexts indicate that geometric shapes and patterns apparently function exceptionally well as signs.

In this study, the formal conditions and constraints underlying the recognition and making of geometric decorative patterns are therefore analyzed within the context of the constraints and conditions under which those patterns become endowed with

[1] Hauser & Spelke 2004, p. 853.

the potential to function as a representation. This analysis allows a more in-depth understanding of how the formal aspects of visual artefacts relate to the ways *in which* these artefacts, embedded as they are within a cultural context, can function as representations of, and references to, bodies, objects and phenomena outside the artefact itself.

Recognizing geometric decorative patterns

Chapter 1 discusses how in the decorative arts there exists an endless number of possible motifs and that those motifs have been distinguished based on formal properties and have been divided in the past by different scholars according to different categorizations. This variety of motifs appears to be distinguishable within three broad categories either as naturalistic, stylized or abstract. This limitation of categories is necessary to arrive at a formulation of the essential invariant properties of abstract geometric motifs regardless whether they are, for example, parallelograms, circles or triangles. It is then concluded that geometric motifs are those motifs, made up of straight and curved lines, which do not appear to look like the bodies and objects humans encounter in their everyday surroundings. A geometric pattern is definable as a regular and repetitive ordering of geometric motifs along one or more axes. This definition is general enough to capture the broad variety of existing geometric decorative patterns but, at the same time, stringent enough to capture the main invariant properties of those patterns. This is necessary to determine the kind of cognitive competences humans would need to recognize those properties.

In the case of recognizing the invariant properties of geometric motifs it appears that humans need to understand the concept of line as well as the geometric properties of length, angle and direction. Besides this, humans require a cognitive competence which will allow them to individuate each motif and understand the pattern as a recursion of elements alike.

From the analysis on the research of cognitive scientists working within the core knowledge paradigm in Chapter 2, it becomes clear that these competences are probably conditioned by innate psychological systems. A further analysis of the results of cognitive scientists conducting cross-cultural research with children and adult participants shows that the ability to recognize the invariant properties of shapes appears to develop universally, independent of, and prior to, formal education in geometry.[2]

The assumption underlying the core knowledge hypothesis which holds that certain aspects of shape recognition are destined to develop in each human being, appears to be supported by research from neuroscience. Neuroscientists identified specific regions in the brain that appear to be involved in the recognition of very specific aspects of shapes and their constituents; some regions appear to be dedicated to the processing of lines, others to lines oriented towards a specific direction, for example, diagonals.[3]

Besides such indications that some aspects of shape recognition might be universal, the discussion of the psychological research also shows that other aspects appear to depend on extended learning and experience. Core knowledge research has made clear that to accomplish mental rotation to understand a feature like mirror-symmetry, a feature very common in ornamental patterns, requires more cognitive effort and experience, for example, with handling three-dimensional objects and probably involves the maturation of the motor system. However, even for those well trained in formal geometry, it appears that mental rotation tasks keep requiring more cognitive effort.[4]

From the core knowledge research, it becomes clearer still that understanding a pattern as a regular arrangement of similar but individual elements is partly conditioned by a cognitive system allowing humans to track a limited number of individual objects. Humans appear to use more complex and unique cognitive competences building on that system to allow the understanding and recognition of larger sequences of elements such as decorative patterns.[5]

In summary, the analysis of respectively decorative patterns and core knowledge in Chapters 1 and 2, shows that the competence to recognize a regular arrangement of

[2] Izard et al. 2011, pp. 324–326.
[3] Tanaka 2003, pp. 90–99.
[4] Izard et al. 2011, pp. 324–326.
[5] Hauser & Spelke 2004, pp. 858–860.

geometric motifs in a decorative context is most probably conditioned by an integration of innate competences, partly shared and partly uniquely human, with culturally acquired knowledge. The findings from core knowledge research indicating that the main ingredients for pattern recognition seem to be present in humans universally, could partially clarify why similar patterns are used in different and remote cultures. However, these findings do not allow an understanding about the conditions under which those patterns function as representations. The condition under which a visual shape can be endowed with the potential to represent, requires that a human subject possesses a cognitive competence allowing that subject to make the inference that a one can refer to, or stand in the place of, another.

Patterns as representations

To understand patterns as representations, a semiotic analysis was undertaken in Chapter 3 so as to identify first, the ways *in which* a visual artefact such as a geometric motif can function as a sign that refers to, or represents. There exists a wealthy tradition of scholarly research on the ways in which signs function. This function appears to depend on both the formal properties of the motif as well as on the cultural context within which the motif signifies. Under some conditions, and in certain contexts, a motif may function as an iconic sign, an index, a symbolic sign or an exemplification.[6]

In regard to geometric decorative patterns and ornament, the study of anthropologist Alfred Gell appears to be particular enlightening. Gell approaches decorative patterns as artefacts having agency and affecting their viewers. Having analyzed and discussed a number of examples that within certain cultural contexts are interpreted as patterns endowed with the power to affect human subjects and evil spirits, Gell concludes that the recognition of the pattern's regular formal order almost automatically urges the human subject to regard each motif within the pattern as an

[6] Peirce 1940, pp. 102–103; Peirce 1931–1958 vol III, p. 361; Goodman 1968, pp. 52–53.

index to another.[7] This means that the implicit referential character of decorative patterns appears to depend on the regularity of its formal order.

In addition to Gell, the study on geometric ornament by art historian Oleg Grabar highlights another aspect of the potential of geometric patterns to function as signs. Grabar makes it clear that because geometric patterns are abstract and at first sight do not look like the objects and bodies from everyday human surroundings, these patterns, enable the agent and the recipient the 'freedom' to invest geometrical motifs and patterns with specific culturally embedded content.[8]

Geometric decorative patterns are thus representational at least in two ways; the motifs of the pattern function as indices within the self-referential structure; the geometric motifs and patterns appear to function as symbolic signs. It is now also clear that the inference humans make that a geometric decorative pattern can refer to, or stand in the place for, something else, relates to the formal properties of patterns to such an extent that from the internal structure of the pattern humans infer and assume that the pattern has a maker and is intentional and therefore also infers that the pattern must mean something, in other words, that the pattern refers to, or represents, something. To further analyze how and on what ground humans make that inference, other bodies of knowledge besides psychology and semiotics are needed.

Knowledge and perception of patterns

Those bodies of knowledge appear to be available from the history of art. The Florentine humanist and architect Leon Battista Alberti already made clear in the fifteenth century, how a practical geometry enables painters to perform, both mentally and physically, certain kind of geometrical transformations on the picture plane, allowing them to construct constellations of points and lines from which visual shapes and patterns emerge; shapes and patterns that have the capacity to refer to something other than itself. Therefore, Alberti's treatise *De pictura*, in which this practical geometry is explained, must be analyzed from the perspective of the apparent human mental

[7] Gell 1998, pp. 76–77.
[8] Grabar 1992, p. 154.

competence to understand abstract patterns, as a competence allowing making representations in the broad sense. From that perspective, the argument unfolds that Alberti's treatise actually makes clear how the rudimentary geometric principles that precondition the competence to make two-dimensional shapes naturally also precondition the competence to suggest complex three-dimensional objects by means of two-dimensional shapes. Those principles appear to be, for example, the principles that lines have length, that lines that intersect form angles and that the number and nature of angles determine the nature of a visual shape. It appears that Alberti's treatise shows that by means of subjecting points and lines to geometric transformations as repetition and rotation, an action Alberti refers to as *weaving a web of lines*, constellations of lines appear, with which the shapes and surfaces of objects and bodies can be represented. Alberti shows that drawing a floor in perspective comes down to drawing a grid of lines that appears to recede towards the background.[9]

The ability to draw such a grid requires a conception of spatial surfaces as being comprised of a number of quantifiable and proportionally interrelated segments. Humans have probably mastered this geometric knowledge over the course of time, for example, when defining the outlines of plots of land; practices which precede its codification as geometric theory. The history of making geographical maps shows how humans have had to integrate the geometrical concepts of angle and direction with that of number, to arrive at such a conception of quantifiable space.[10] The example of making maps also makes clear how, in a certain context, a geometric ordering can make present something which the ordering itself is not; in this case a piece of land or a sea.

To see, within a constellation of lines, the side of the gable roof of a house, or to see an open book, comes down to the recognition and interpretation, within that same constellation of lines, of a parallelogram as a representation of a roof or a book. Alberti's practical geometry thus appears to be particularly relevant with respect to how representation works as it allows identification of the specific moments when shapes and patterns on the flat surface appear to become susceptible to be endowed with the potential to represent. From that perspective, Alberti's practical geometry is highly

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[9] Alberti, *De pictura*, $ 19 & 20.
[10] Edgerton 1975, p. 114–115.

informative since it appears to anticipate certain aspects of modern cognitive psychology on the human understanding and acquisition of core geometric concepts.

When confronting Alberti's practical geometry with modern cross-cultural research from cognitive psychology, it appears that even though the theory of linear perspective clearly emerged from a culturally and historically determined context, adults and children not raised within that context and not trained in formal geometry, are nevertheless able to comprehend geometric concepts such as angle and length that also underlie the making of perspectival images. The adults and children who participated in these psychological experiments appeared to be able to use those concepts to identify geometrical shapes like triangles, rectangles, parallelograms and trapezoids.[11] In other words, they had the cognitive building blocks available allowing them to recognize geometric motifs and patterns, their formal properties and to a certain extent the geometrical transformations to which they can be subjected and which are fundamental for making representations like perspectival pictures. From that insight it can be assumed that the competence to interpret a geometric shape as a representation of, or a reference to, is probably also present in humans worldwide. However, cultural practice shows that the interpretation of a specific geometric shape, such as a parallelogram, as a representation of a specific object, such as the side of a gable roof, is largely culturally determined.

The materiality of making patterns

With his practical geometry Alberti already implicitly showed that recognizing and making abstract shapes and patterns requires certain mental competences but eventually Alberti wrote his tractate with the aim that his practical geometry would be practiced indeed by makers of images, more specifically, the fifteenth-century painter. Therefore, in Chapter 5, it is made even more specifically clear that recognizing and making patterns as representations, seems not only conditioned by cognitive competences but also that it involves physical and material aspects that should not be ignored. With regard to the physical and material aspects of pattern production, the close reading of

[11] Dehaene, Izard, Pica & Spelke 2006, p. 382.

the main theoretical works by architect and art historian Gottfried Semper makes clear that Semper in the nineteenth century added a whole new perspective on the emergence of the decorative arts. Analyzed in retrospect, Semper's theory indicates that Alberti's metaphor of drawing as weaving a web of lines, could appear to be more than just metaphor. It is made clear that Semper's argument concerns the way in which, in early human settlements, the principle of making patterns would have come naturally with weaving. The early weavers would have connected natural threads to create a two-dimensional pattern that formed a surface, namely a piece of cloth, that functioned as the literal surfaces of the early tents. Semper was one of the first to implicitly suggest that those early weavers must have had a rudimentary cognitive concept of line, which the weaver was able to apply in a material context using threads of natural fibres. It is discussed how Semper explains the ways in which those early patterns became representations when, for reasons of construction and durability, those once woven patterns were imitated in other materials, for example, in stone. Those 'imitations' literally became the representations of the earlier techniques and practices to which they owed their existence.[12] This means that with Semper it is possible to show how decorative patterns are representational in yet another way; decorative patterns always contain indices of earlier motifs and of previous techniques of manufacturing.

With his emphasis on the physical and material aspects of pattern production processes such as in weaving, it appears that Semper's theory is complementary to Alberti's practical geometry when viewed from a cognitive perspective. Alberti already made clear how a basic knowledge of formal geometry, such as an understanding of the concept of line, angle and length, enables artists to create two-dimensional shapes and patterns that can become representations. With Semper it became clear later how the understanding of geometric knowledge might have emerged from the application of rudimentary mental concepts within the context of actual processes of the physical manipulation of natural materials. This complementary aspect between Alberti and Semper has not been emphasized so explicitly until in this thesis. Both appear to depart implicitly from a conception of line as a fundamental mental abstraction. Alberti's treatise showed how the ability to abstract line from contour is a precondition for

[12] Semper 1851, pp. 57–59.

recognizing and making constellations of points and lines, which someone does when drawing. In addition, with Semper it shows how an abstract concept of line applied to natural materials must have enabled the weaver to construct the patterns that arise from the technique of weaving. Moreover, Semper shows how the physical process of creation, by means of which threads are woven into patterns, is a sequence of events in space and time and itself a pattern that becomes materialized as the visual and recognizable pattern indexing its maker and its manufacturing.[13] Semper's argument therefore urges one to consider the competence to recognize and make geometrical patterns in decorative contexts, to have emerged from a combination of physical, technical, material, and cognitive skills embedded within a specific human and cultural context.

Conclusion

The interdisciplinary and theoretical analysis carried out in this study has made clear that the competence to recognize the shapes of objects, the competence to track a limited number of individual objects, and the competence to understand, in a rudimentary way, geometrical concepts like angle and length, form the pre-conditions for the recognition of geometric patterns. These competences also enable humans, at least in the early stages of creation, to constitute the constellations of points and lines that will form the shapes and surfaces that can represent bodies and objects in images in general. Moreover, these competences appear to condition the recognition and making of geometric patterns in a variety of decorative contexts. Practices such as weaving, which are inherently pattern-like, show that humans can apply their mental conceptions of line, angle and length to many materials and phenomena to create visual patterns whether the result is a drawing, carving, cloth or other visual artefact. Cultural practice also indicates that the competence to recognize and make geometric decorative patterns should not be understood exclusively from the perspective of underlying cognitive competences, but as something humans actively perform.

[13] Semper 1860, p. xxi.

This also applies to the ways in which humans endow abstract shapes and patterns with the potential to refer and represent. It can be concluded that the competence to make meaningful associations between abstract patterns and objects, does depend on the recognition of the formal properties of patterns to the extent that from the formal and regular order of the pattern, humans infer those patterns have a maker and therefore must be intentional and mean something. The actual association itself, however, does not have to depend on formal likeness between the abstract shape, or pattern, and the objects they potentially refer to or make present. Such associations probably depend on cultural context, language and memory. Abstract patterns used in ornaments such as the geometric patterns discussed in this thesis are thus by far non-representational; on the contrary, they exactly show how representation works.