The Psychologies of Gestalt Principles of Visual Perception and Domain Expertise: Interactions and Implications for Instructional Practice

Steven J. Condly
University of Central Florida, Orlando, Florida

Gestalt psychological principles of visual perception, demonstrably robust and ubiquitous, can and should inform both teacher education and general educational practice. While perhaps inconvenient, these principles nevertheless accurately describe some of the inherent biases and flaws in visual information processing. However, their association with educational practice rarely is made manifest. Recent work in the cognitive psychology of the development of expertise helps explain why these principles matter to learning and performance. Together, these two strands of psychology can assist educators in properly structuring their visual presentations of information so as to maximize student learning. This understanding is especially important as education continues to move to an increasingly visual-type format for instruction via computers, the internet, CD’s, DVD’s, and PowerPoint. Teachers need to understand how the biases inherent in visual information processing work so as to mitigate their negative effects, take advantage of their positive effects, and thus improve student retention and use of knowledge.

The Psychologies of Gestalt Principles of Visual Perception and Domain Expertise: Interactions and Implications for Instructional Practice

Sometimes the science of psychology can seem so esoteric that it would appear to have little if any relevance for such a practical endeavor as educating school-aged children. For example, the Stroop test is a phenomenon that is discussed in every freshman psychology class. In the Stroop test, subjects are asked to report, as rapidly as possible, the color of the word or object shown on a computer screen. Initially, the words of colors are shown in matching color (Red is shown in red “ink”). Next, rectangular bars of solid colors are shown. Then, unrelated words (like Car or Vase) are shown in varying colors. Finally, color words are shown in mismatched colors (Blue is shown in yellow
“ink”). As the tasks progress, response latencies increase. It is easy to see how such an activity, although perhaps interesting, would fail to impress a teacher-trainee. After all, what teacher would perform such an activity in class? However, the educational relevance of the Stroop test is identified in the following statement: As attentional demands of a task increase, speed of performance decreases. Now that is something that matters to professional educators. Classroom activities vary widely in the kinds of skills and abilities students bring to bear on them. For those tasks which require careful and sustained attention, teachers cannot expect rapid performance. For routine and well-practiced tasks, teachers can (and perhaps should) expect speedy performance. Thus, teachers need carefully to plan the amount of time they will give students to complete tasks. To allow an hour for a 20-minute task is to lose students to boredom and horseplay; to allow 20 minutes for an hour-long task is to diminish self-efficacy, effort, and ultimately, achievement.

The same logic can be applied to the Gestalt principles of visual perception. Perception is defined as “the set of psychological processes by which people recognize, organize, synthesize, and give meaning (in the brain) to the sensations received from environmental stimuli (in the sense organs)” (Sternberg, 2003, p. 534). Gestalt principles are those which “describe how we perceive whole patterns and organize information into meaningful units” (Cassells & Green, 1991, p. 43). Perception can be studied at a very basic, or atomic, level. Teachers, however, tend to operate on a molar level where the unit of analysis is not a particular micro-phenomenon but a person. Thus, it is possible to dismiss perceptual psychology as too basic to be of use for practice. Such a dismissal,
however, can jettison some very valuable information which can assist educational practice.

What follows is a listing, description, and discussion of five Gestalt principles of visual perception. While it is true that not all information presented and operated upon in classrooms is visual, it certainly accounts for a great deal of it. Students read texts, watch videos, look at computer screens, scan pictures, stare at chalkboards, etc. Since most of what is learned in classrooms is visual in nature, it should come as no surprise that a psychology of visual perception can inform both curriculum and instruction.

Principle One: Figure-Ground

When perceiving a visual field, some objects or aspects of objects seem prominent, and others recede into the background. The former are called figures; the latter, ground. In Figure 1 below, most individuals report the figure as the vase and the ground as the two faces.

Figure 1

Instructions, or prior information, can lead a viewer to focus on, or expect to see, either the figure or the ground (Cassells & Greene, 1991). For example, if a class discussion had been about interpersonal relationships and conflicts, then more students would report seeing the two faces (rather than the vase) than if the class discussion had been about ancient civilizations, pottery, interior design, or art. The educational imperative here is
that through the use of prior information an instructor can “bias” a student’s perceptions in one direction or another. This is useful in certain situations, and not in others. It is useful when the instructor needs for students to concentrate on certain key information (not to miss the forest for the trees, as it were).

Often, in the midst of much information, students miss the main point, or else they focus on minutiae or trivia. A skilled instructor will present the information such that the main points remain emphasized and obvious; supporting information is presented merely to buttress the main ideas. This is not useful when one is exploring various viewpoints or competing philosophies. For example, when discussing the root causes of war, there are many different explanations with different emphases, data sources, and political and moral philosophies. In such discussion-type sessions, students need to be listening to all voiced opinions, not merely those with which they agree.

The figure-ground principle is helpful to consider when there is much information presented to novice learners. Novices, due to their limited background knowledge, often are in no position to distinguish between what is important and what is trivial or irrelevant (Gagné, Yekovich, & Yekovich, 1993). Since the natural human disposition is to focus attention on the figure, the instructor will want to increase the chances that students will perceive important information as figure, not as ground.

This kind of technique would be inappropriate where brain-storming is occurring, or when students are involved in exploratory activities, and the like. In such cases, one of the main points of the exercises is the development of students’ own willingness to think, be creative, risk opinion and thought, and to attempt to induce patterns from examples and information. Under these circumstances, less strict guidance from the teacher is in
order, though the teacher still must ensure that such activities result in some measurable educational or mental product.

Principle Two: Proximity

Whenever we view an assortment of objects, we tend to see objects that are close to each other as forming a group, and objects that are farther from the group as being immaterial or unrelated.

Figure 2a

A A A A A A
A A A A A A
A A A A A A

Most individuals, upon being shown such a collection of letters in Figure 2a, indicate that they perceive rows, not columns, of A’s.

Figure 2b

A   A   A   A   A   A   A
A   A   A   A   A   A   A
A   A   A   A   A   A   A
A   A   A   A   A   A   A
A   A   A   A   A   A   A
A   A   A   A   A   A   A
A   A   A   A   A   A   A
A   A   A   A   A   A   A

In Figure 2b, even though the letters are identical, more people would report perceiving columns than rows of A’s.

Figure 2c

A A A A A
A A A A A
A A A A A
A A A A A
A A A A A
A A A A A

Here in Figure 2c, because the overall shape is almost perfectly square, and the vertical and horizontal spacings are approximately equal, individuals alternate in their perceptions of columns or rows (although, in fact, more people would report perceiving rows than columns since English is read horizontally, then vertically).

When bits of information are presented fairly closely together in space and time, individuals are predisposed to perceive the information as necessarily belonging together, as being related. This is normally not a problem. It can be a problem if, for instance, in an effort to “get kids more interested” in the lesson about the American Revolutionary War, a history teacher adds irrelevant information (regarding the peculiar personal habits of the principle figures of the period) to the lecture. It is important for educators to remember that students are novices, inexpert individuals who lack considerable domain-specific knowledge. A reasonable conclusion for students attending the aforementioned history class would be that such humorous information somehow mattered in the war, that it might show up on the test, and that the Founding Fathers’ peculiar habits were just as
important to the nation’s founding as were their political philosophies. Experts are in a position to sift the wheat from the chaff, novices are not. Thus, in the initial stages of the presentation of information, teachers are well-advised to stay clear of irrelevant information, lest it be incorporated into their students’ schemas (Gagné et al, 1993).

Principle Three: Similarity

People tend to group objects on the basis of their perceived similarity to each other.

Figure 3

Even though there are both columns and rows of circles and squares in Figure 3, most people perceive a diagonal line of squares amid circles. One square does not necessarily “go” with other squares; that is, there is nothing lawful which requires people to perceive a diagonal line of squares rather than just columns or rows of differing figures. However, in the interests of mental economy, we are psychologically (perhaps even neurologically?) designed to identify similars among collections of objects, and thereby perceive a pattern.

Educationally, problems can arise as novice students learn concepts and attempt to solve problems. For example, if in physics class students work on problem 8 (which
involves a red car traveling at 30 km/hr for 3 hrs), and need to determine time, they may become biased toward the kind of problem being asked if, in problem 9 they are given a dynamics problem asking for the calculation of force, but the problem also involves a red car. That is, students may equate the two problems (even though they ask for different things) just because they both involve a red car. Such logic surprises and frustrates experts, but is part and parcel of novice thinking. Again, given the qualitative differences in the knowledge bases and thinking processes of novices and experts, teachers need to vary the irrelevant parts of problems lest students inadvertently focus their attention on that information. Novices tend to concentrate on the superficialities in problems; experts, on deep structures. Thus, novices could easily fall into a solution rush in problem 9, treating it just like problem 8, even though the two problems differ markedly (see Gagné et al., 1993, for a discussion on the respective natures of expert and novice knowledge and thinking).

Principle Four: Continuity

People tend to perceive smoothly flowing or continuous forms rather than disrupted or discontinuous ones.

Figure 4

Does \( \times \) equal \( / \) and \( / \) or \( \backslash \) and \( \backslash \) ?

Most individuals would perceive the “X” to be composed of the two diagonal lines rather than the upside-down and rightside-up “v’s.” Of course, the “X” is easily manufactured from either set. The tendency, however, is for people to follow information in series, to
accept flow, rather than to build understanding based on seemingly disparate (or unconnected) information. One of the advantages experts have over novices is the depth, breadth, and interconnectedness of their knowledge bases (Ericsson, 1996). Obviously, experts know more than novices do; that is, their knowledge is deeper. But their knowledge is also better connected to related and seemingly unrelated phenomena as well. Additionally, their knowledge structures are far better organized than those of novices, and these structures are organized according to deep principles rather than according to superficialities. What this means is that when experts are exposed to new information within their field of expertise, they generally know what to make of it, how to categorize it, and how to use it in problem solving, even if the information arrives in discontinuous fashion. This is not true of novices. If information B follows A, then the novice will often assume that B ought to follow A. Statistics professors all too often have to fight to convince students that just because one event followed another does not mean that the first event caused (or was even related to) the second (see Piattelli-Palmarini, 1994, for a discussion of this and other cognitive illusions that govern human thinking). Experts can hold “out-of-place” information temporarily in working memory until such time as they can either use it or store it. Novices, whose working memories often operate at capacity when involved in new domains, cannot do so (Baddeley, 1997). Thus, they simply connect B to A because B followed A.

Professional educators are advised to present information, both visually and orally, in such manner as the presentation sequence makes logical and domain-specific sense. The serial nature of novice problem solving ability demands that information be presented only when appropriate, not before, and certainly not after, it is needed (van
Merriënboer, 1997). The “whole” that a novice will perceive will be greatly influenced by the sequence in which the domain-specific information is presented. It is only when a minimal level of expertise is developed within students that problems which are superficially confusing should be presented. Once expertise is attained, information can be processed in parallel, with much of the mental operations taking place automatically; that is, at high speed, but unconsciously.

Principle Five: Closure

Individuals tend to close up, or complete, objects that are, in fact, not complete.

Figure 5

Most people would identify Figure 5 to be a square when, in fact, it cannot be since squares are closed regular figures. It is easier to imagine that something is occluding the lower right corner of the object than it is to come up with a new category for that object.

One of the more interesting facts uncovered by cognitive psychologists is that approximately 90% of adult knowledge is automated and unconscious (Bargh & Chartrand, 1999). It is certainly true that the knowledge possessed by experts is more fully automated as compared with the more conscious declarative knowledge possessed by novices (Anderson, 2000; Ericsson & Smith, 1991). What this means is that when expert teachers instruct, oftentimes they perform tasks (such as solving problems on the board, identifying nouns in sentences, hitting a baseball in PE class) in such a manner
that their procedures operate beneath their conscious awareness. In other words, because of their repertoire of automated skills, experts often cannot describe how or why they do what they do; they simply do it (Gagné et al., 1993).

These findings emphasize the need for the instructor to perform a complete task analysis for each problem set in the curriculum (see Schraagen, Chipman, & Shalin, 2000, for a description of how to perform such an analysis). When instructors present information, they often do not mention facts or steps that, while important, are part of their automated procedural knowledge. The result is an expert performance, but a verbal or visual description that is less than complete. Novice students are operating almost exclusively at a conscious level with the few declarative knowledge bits at their disposal. Their perception of the situation will be that it is incomplete. According to Gestalt psychology, they will not leave the situation incomplete; they will fill in the blanks. However, because of their naiveté, their final construction of the process or product will very likely be incorrect. Thus, it is incumbent upon instructors to present information in as complete a form as possible, lest their inexpert students attempt to complete the information based on their limited knowledge. (Incidentally, this imperative does not preclude the use of knowledge construction-type tasks such as exploratory labs; it merely highlights the need for instructors to guide student interaction and to supervise the development of student understanding of the topic at hand).

Perceptual Set

Cognitive psychologists have written extensively on the various cognitive biases that affect our receipt and organization of information (Dawes, 1988; Evans, 1989;

One of the biases we all possess is perceptual set.

Perceptual set is defined as “a mental predisposition to perceive one thing rather than another” (Cassells & Green, 1991, p. 43). Allport (1955) defines it as a perceptual bias or predisposition or readiness to perceive particular features of a stimulus. Thus, even though a person looks at a collection of objects, or receives information through his/her eyes and ears, it does not necessarily follow that what is perceived by that person is what all other persons would perceive. Because perceptual set involves predispositions, there must be influences on the mind that create those predispositions. Two such influences are expectations and experience (Cassells & Green, 1991).

Marcel (1983) demonstrated that the expectations of individuals could influence how readily they could perceive words. In a series of experiments subjects were shown words like “blood” for only a few milliseconds and then words like “flood” (graphically similar), “flesh” (semantically similar), or “cargo” (unrelated). Recognition response times were recorded. Whether the second word of the word pairs was semantically or graphically similar to the first word was irrelevant; response times were quicker in those instances than when the second word was unrelated. Marcel argues that there is an unconscious biasing effect that predisposes the individual toward certain kinds of information. Thus, educators can predispose students towards certain expectations just by virtue of the kinds of information they present in class.

In similar fashion, Bruner and Goodman (1947) found that poor 10-year old students were less accurate in their estimations of the sizes of pennies, nickels, dimes, and quarters than were rich 10-year olds. Presumably, the greater familiarity on the part
of the wealthy students enabled them to guess more precisely from memory the sizes of the coins. The import of this relatively obscure research should not be lost on educators. While it is certainly true that any student could be taught the relative sizes of US coins and draw them out by memory, it is also true that those students with the greater background knowledge (or experience) will be able to perform the task more quickly than students with less familiarity. Thus, teachers need to become students of their students; they need to know what their students know and what they don’t, and then adjust instruction accordingly.

Conclusion

The old adage, “you can’t fight city hall,” applies to the relationship between gestalt principles of visual perception and education. Human beings operate according to certain physical and mental laws. The airplanes we fly work because designers have considered (and not fought against) phenomena such as gravity, Bernoulli’s principle, energy transformation, etc. In the mental realm, we process information according to identifiable laws. For example, it is known that the capacity of working memory is $7 \pm 2$ chunks (Miller, 1956); therefore, when new concepts are presented too many too quickly, the human memory system quickly overloads. The effect is that learning does not take place. “Fighting city hall” would involve instructing students in such a manner as to violate mental laws. Airplanes designed with disregard for phenomena such as temperature, tensile strength of materials, and gravity do not fly. Instruction which violates Gestalt visual perception principles does not educate.

Instructors would be well-advised to consider the whole person they are instructing and educating. The perceptual inclinations we all possess influence the
processing and organization of the information to which we are exposed. Instructors, therefore, should consider these inclinations and not just avoid them when they are detrimental to the education process; rather, they should turn them to one’s advantage. The design of instruction that incorporates Gestalt principles is more likely to assist students in processing information correctly than is instruction which is designed contrary to these principles. This is so because Gestalt principles accurately describe what is true for people, not what ought to be true. As such, it must be considered in instructional design; otherwise, the best one could hope for in instructional design is a healthy dose of luck to make up for what is lacking.
References


---

**Author Note**

Steven J. Condly, Ph.D., is a professor in Educational Studies at the University of Central Florida in Orlando, Florida.

Copyright 2003: Steven J. Condly, and University of Central Florida
Article Citation