

A Constructivist Approach to Teaching Motion Picture Photography

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Introduction

Over the years, there have been literally thousands of scholarly studies of the human ability to draw. Most of these studies have focused on the drawings of young children, since their drawings shed some light on the processes of growth and perception at work (Strommen, 1988). On the other hand, there have been almost *no* scientific studies of the process young adults go through in learning to use a camera. What studies there are have mostly addressed the content of their imagery, or technical issues in dealing with the editing system, rather than the learning process itself (see, for example, Baecker and Posner, 1999). The lack of scientific literature on photographic ability as a growth process is probably due to the mistaken assumption that photography is nothing more than the passive observation of preexisting things, and that picture quality is more a matter of technology than visuospatial skills.

Good photography, both still and motion picture, requires developing certain aesthetic and expressive sensibilities – skills which are both related to, and yet different from, those of the graphic artist. In the process of learning to use a camera, students learn valuable communication skills, increasing their abilities to share experiences and information through visual media. They also learn to see the persuasive techniques in the entertainment and advertising media that surround them every day. And in the process of sharing their work, students find new ways to relate to their peers and their community. Becoming a photographer is a very *active* process, in which students learn to see in a different way, and move through the environment in the process of seeking out effective visual images.

Motion picture photography has been an exciting area for me to explore as an educator. In the six years I've been teaching the subject at HCC, I've delved into theories of learning at the intersection of art education, cognitive science, narrative, and movement. Photography is an ideal subject for constructivist educational techniques, which encourage students to develop their skills and knowledge in a bottom-up, self-directed exploratory approach. My constructivist approach differs significantly from the typical methods of teaching moviemaking, and I believe I get better results through the application of modern concepts in education and cognitive science. My approach avoids content issues such as plots and scripts, and focuses instead on developing visuospatial sensibilities with the camera. I treat the camera as an actor, and students go through an experiential process somewhat similar to the training process for actors (see, for example, Bogart and Landau, 2005).

I don't want to suggest that I have some formula for creating good cinematographers. In my Fundamentals of Video class, I give out my share of bad grades. Like any art form, motion picture photography depends on the individual finding his or her voice through a medium of creation and expression. What I have is a framework of reference that sees student work not as "good" or "bad" movies, but rather

as indicative of an ongoing growth process. It allows me to see where students are getting stuck in their own process, and offer specific suggestions for moving forward.

I use the terms *photography* and *cinematography* fairly interchangeably, since there is much in common in the early stages of learning. Motion picture photography, of course, allows considerable variation in the dynamic movement of the camera, or of the things in front of it. But underlying both forms of photography is the photographer's exploration of space, and placing the audience's eyes in locations that capture expressive views of what's there.

The Hollywood Model

Moviemaking is usually taught through what might be called the "Hollywood Model," since it's analogous to the process used in making commercial films. Moviemaking is presented as visual storytelling, with an emphasis on the movie's content as a series of events involving actors. The student first creates a story in his or her mind; this story is turned into a script; storyboards are drawn that illustrate each shot; actors are recruited; locations are found in which to shoot; the movie is acted out, photographed and recorded into raw material; and then the raw material is edited into a finished production.

This process works passably well for students who have experience with a camera, creative writing and drawing. But for newcomers, this is often a difficult process, with disappointing results. How do you create a story in your head? How do you turn that story into hand-drawn pictures? And how do you go from those drawings to a real world enactment? Each step in the Hollywood Model presents challenges that can be better addressed by an experiential approach to the subject, one that assumes nothing about what students know, and allows them to develop new abilities through hands-on experience with the camera.

Most of the students in my classes have spent hundreds of hours watching movies in theaters and on television. Yet when they take the camera in their hands, they can't even begin to reproduce the actions taken by professional cinematographers. Students can tell me all about the plots, the actors and directors – but they don't recall the specific ways their favorite movies were constructed. In watching a movie, they look *through* the camera at what's seen, but they don't see the behavior of the camera itself. Movies have a way of transporting us into their worlds, through a phenomena called *presence* (Waterworth, Waterworth, and Westling, 2002). A well-crafted movie prompts us to turn off our analytical faculties, and experience being somewhere else, inside a constructed reality. A poorly crafted movie, on the other hand, stands and watches its subjects impassively, or annoys us with inappropriate behavior.

Teaching with the Hollywood Model suffers from a lack of connectedness between mind and body. The conceptual work is all done in the mind, before any use of the camera. Students are supposed to think their way through the process before they even pick the camera up. In shooting the movie, the photographer's body is merely a servant carrying out the mind's preconceived instructions, not involved in the creative process at all. Storytelling, in this approach, is very "top down," starting out with the big concept in the student's head, and working downwards to flesh out the details with the camera. The

beginner usually doesn't know how to capture details that convey what needs to be said; and in fact, doesn't realize that those expressive details are missing.

There's an axiom in the art world to the effect that "young children draw what they know, while older children draw what they see" (Cox, 2005, p. 71). Young children draw with a strongly schematic approach, which gradually becomes more realistic as they get older. There is a similar quality in the work of novice photographers, even in their teens and older. They're usually more involved with the idea of what's in front of the camera than they are with the visual experience of those things. This is not a function of the age of the artist, but rather the result of a lack of experience with the medium (Arnheim, 1974, ch. 4). They're not capable of handling complexity in their images, and unconsciously do things to avoid it. The challenge of teaching motion picture photography is to get the students to think in terms of pictures, and not just the things and events in those pictures. The novice sees *through* the viewfinder at what's there, while the skilled photographer looks *at* the viewfinder as a picture of what's there, and moves his or her body in space to control that picture.

A list of expressive camera behaviors would be large, and undoubtedly incomplete. The Gestalt psychologists of the early 20th century listed some of the most useful perceptual principles in two-dimensional graphics, which we can adapt and expand for use with motion picture photography. Some of these are:

- **Proximity:** The human nervous system is hard-wired to pay attention to what changes, and ignore what doesn't change. By altering the distance to what's changing (a person moving, for example), the cinematographer controls the way the audience attends to that change. Beginners tend to stand too far away from their subjects, and tend to shoot standing up. Experienced photographers often shoot closer to their subjects, and lower than eye level.
- **Symmetry:** A subject in the center of the visual frame creates a sense of balance and stasis, while one off-center suggests a more dynamic situation. Beginners tend to put the subject in the middle of the frame, and try to keep it there when the subject moves. Experienced photographers use imbalance for expressive purposes, and allow a moving object to travel through a stationary visual frame.
- **Closure:** This is the degree to which the subject is contained within the visual frame. Beginners do this without thinking, while experienced photographers allow the subject to extend partially out of frame, which is often more engaging.
- **Angularity:** Beginners tend to keep major lines horizontal or vertical, and to see things from the front or directly from the side, sometimes called the "Egyptian treatment," after their early art (Arnheim, 1974). Experienced photographers create a sense of direction and perspective by using angles.
- **Framing:** Experienced photographers sometimes use natural edges and shapes in the foreground to act as visual containers for the subject of the shot, while beginners rarely do.

The philosopher Vilem Flusser (1984) described photography as a process similar to hunting, the photographer "stalking" visual prey. The subjects of pictures can be

thought of as things to be captured, while these expressive behaviors of the photographer moving through space are the methods for ensnaring them, and delivering them to the viewers. Beginners tend to tackle their prey head-on, quickly; while experienced photographers have developed skills to explore the space around their subjects, postponing commitment to a shot until they've tried a variety of approaches – in effect, sneaking up on subjects for better results.

When we operate a movie camera, we aren't just holding some electronic device in our hands. The camera becomes, in effect, the audience's eyes. Around and below those eyes is a "virtual body" through which the audience inhabits the space of the movie. The cinematographer's patterns of behavior with the camera become the audience's manner of inhabiting this space (Freedberg and Gallese, 2007). To some extent, the audience is interested in what's shown because the camera tells them they are interested, and tells them how they react to what they see. The motion picture camera is an actor, reacting to what happens before it. In a well-crafted movie, the audience develops a sense of trust in the camera. They lose the sense that they are watching something on a screen, and they inhabit the movie world – a psychological phenomena called *presence* (Riva and Waterworth, 2003). This sense of presence is easily damaged by careless handling of the camera. But on the other hand, a sense of presence isn't that hard to create, either.

Constructivism

Constructivism is an educational philosophy that seeks to teach through the accumulation of real-world experience (Davis, Sumara, and Luce-Kapler, 2000), an approach that is ideally suited to nonverbal subjects such as photography. Constructivists see the mind not as a container of thoughts, but rather as a biological process that unites perception, cognition and action into one self-maintaining, evolving, dynamic system. *Learning* is the process an organism goes through as it adapts to changing conditions in the environment.

The seminal research on human cognitive development was the work of Jean Piaget in the middle of the 20th century, in which he documented the evolving cognitive abilities of children (Piaget, 1954), abilities that grow and strengthen through interaction with the world around them. Shortly thereafter, biologists Humberto Maturana and Francisco Varela (1992) coined the term *autopoiesis*, meaning "self-organization." What Piaget had documented, Maturana and Varela explained, was the human nervous system learning to manage itself, and constructing a person (an active perceiver) in the process. Negotiating new experiences leads to controllable circumstances, and the developing personality gains new resources for interacting with the world around it, and for managing its perceptions.

As an example, consider the process of learning to drive a car. When I first sat behind the wheel as a teenager, I couldn't tolerate having the radio on while I was driving – it was perceptual noise, too distracting, and I needed to focus all of my attention on controlling the car. Today, I drive to work with the radio on, nursing a cup of coffee with one hand, and a bagel in my lap. The process of controlling the car has largely become *automatized*, so that it doesn't take much work. I control the car more by willing it to happen than by conscious attention. Years of experience have allowed me to build

cognitive structures that unite vision and motor movements into a repertoire of subconscious car-controlling behaviors – lane changes, parallel parking, and so on – so that my conscious mind is free to listen to the radio and sip coffee.

Learning to be a photographer involves much the same process. At first the student has to concentrate on controlling the instrument, pointing it at something of interest and holding it steady. But through experience, the process becomes much more automatic. The photographer's mind becomes more tolerant of, and in fact, can make good use of, visual noise such as perspective, surface texture and shadows. The photographer is free to concentrate on the larger goal of what's being accomplished, while the body takes care of many of the details of "driving" the camera on a subconscious level.

Piaget maintained that cognitive growth happened as a result of matching patterns of perception with patterns of action – in other words, the child's perceptions of the environment become linked with patterns of behavior as a result of interacting with that environment. New patterns of perception and behavior build on memories of previous experiences, with concepts being the glue that hold it all together. The brain builds new skills on top of old ones as these new neural connections find places for themselves through trial and error (Fischer and Rose, 1994). It's very Darwinian, with the successful patterns becoming firmly connected in the evolving brain structure, and the unsuccessful connections being removed and forgotten over time. Even in adults, new perceptions can be acquired and become the basis for new skills (Yan and Fischer, 2002), proving that it's possible for old dogs to learn new perceptual tricks, albeit more slowly.

Starting Simply in Movies

The challenge for a constructivist in the photographic realm is to redefine "learning to see" as a process of connecting and refining patterns of perception and movement. This happens as a result of experience with the camera, and can be accelerated through exercises that call for approaching shots in a number of different ways. On the first attempt at some particular subject (for example, a person entering a room and sitting down), students often take the simplest approach. But by requiring them to do it several times using different vantage points, they can compare the results, and get a sense of how different approaches produce different qualities.

Equally important is the experience of sharing the results with classmates and the teacher. I keep critiques in my classes grounded in the physical actions that produced the images on screen, and the effects they have on their audience – at least until the students demonstrate enough skill in controlling the physical aspects of cinematography. And I encourage students to comment on each others' work, looking for what works and what doesn't work.

I believe that developing a sense of "visuospatial grammar" makes a better starting point for beginners than dealing with plots and characters. It's impossible to construct a narrative without some language in which to construct it. Language is not just a conveyance for ideas, but also a medium in which we construct those ideas (von Glasersfeld, 1995). Treating motion pictures as a type of language suggests that students need to learn how to articulate simple phrases in this visuospatial language before they

can construct meaningful stories. A constructivist approach to the visual language of motion pictures allows students to start with the simplest subjects and camera behaviors, and build toward more complex narrative as they gain experience.

The simplest activities can serve as excellent “stories” for student movies. Everyday acts such as making a sandwich, changing a tire, skiing or swimming can come to life when captured with good camera skills. Any number of different subtexts can be suggested by camera behaviors, which bring a kind of personality to the movie. I’ve seen student movies about Jesus joyously making a peanut butter and jelly sandwich, and a dying man whose greatest desire is for one last ham and cheese on rye. In each case, we have a simple activity performed by a non-actor. And both are enjoyable to watch, because they are infused with a sense of personality.

I’m sure there are many people who would argue that this sort of approach isn’t appropriate for students, because it doesn’t aim at making “good” movies. My response is that students are surrounded by such silly little movies every day, in television commercials. A select group of cinematographers works very hard to infuse simple everyday acts with personality and wit, in an attempt to make us feel a certain way about their sponsor’s product. Students should understand the principles of this visual rhetoric, and use this as a springboard for bigger and better things – or at least, be informed consumer of television’s wares. I believe that beginning cinematographers can learn as much from watching television commercials as they can from *Citizen Kane*, and it doesn’t require a trip to the rental store. All movies actually make use of the same perceptual principles; it just happens that they’re often exaggerated in commercials, which makes them easier to see.

The Nature of Expressive Properties

How do we capture pictures with a degree of personality, showing some kind of subtext? The answer, I suggest, is by selectively *distorting* the audience’s view of what’s there. The problem with most beginner’s movies is that they capture things too simply, too clearly. To be expressive, and to nudge the audience into seeing things a particular way, the cinematographer needs to selectively interfere with what a person would see by simply standing and looking from the sidelines with maximum clarity.

Neuroscience has determined that there are two pathways for light stimuli as they are being processed by our brains (Palmer, 1999, p. 38). The entry points, namely our eyes, are connected to the visual cortex in the back of our head by one set of neural processes called the *ventral* pathway, and another set of processes called the *dorsal* pathway. These aren’t simply parallel bundles of neural wiring, but rather two entirely different interconnected neural processes. The nature of these processes and their interaction explains a lot in terms of how students learn to see meaning through the viewfinder of the camera.

The dorsal processes are often called the “where-is-it” circuits. This part of the brain detects surfaces and edges in the light entering the eyes, and makes spatial sense out of what’s in the environment. Walls, tables and chairs, doors and windows are detected by these circuits – not their identity, but simply their visible surfaces and edges.

The ventral processes are often called the “what-is-it” circuits. This part of the brain determines the nature of what’s being seen. The walls, tables and chairs, doors and windows are identified as such by this set of processes, based on the memory of what’s previously been seen and experienced. The ventral processes don’t just put labels on the things before us, but are quite context sensitive. We aren’t robots, after all – we move through the world with purpose, and we look with purpose. If I want to sit down, for example, the ventral processes determine objects suitable for that purpose, and the interaction between these two processes will direct my gaze toward a chair. But if the room suddenly began filling up with water, I might look around for something to stand on to get off the floor. What was seen as something to sit on a minute ago might now be seen as something to jump up on to avoid getting wet.

Perhaps the best explanation for just what the phrase “learning to see expressively” means can be drawn from the work of James Gibson, a prominent vision researcher who was active in the middle of the last century. Gibson (1977) had an interesting perspective on the what-it-it and where-is-it perceptual circuits. He coined the term *affordances* to talk about the perception of things in term of what function they afford the viewer within the current situation.

The what-is-it ventral circuits don’t just put labels on the things before us, but are quite context sensitive. We aren’t robots, after all – we move through the world with purpose, and we look with purpose. If I want to sit down, for example, my ventral processes are seeking objects suitable for that purpose, and the interaction between these two processes will result in my gaze being attracted to a pattern of surfaces and edges that constitute a chair. But if the room suddenly began filling up with water, I might look around for some way to get off the floor. The chair that was seen as a surface to sit on a minute ago might now be seen as a surface to stand on to avoid getting wet, although I’m looking at the same chair. The interaction of these two circuits is responsible for creating Gibson’s affordances (Neisser, 1989).

Gibson believed that most animals (and certainly humans) see their environment this way, learning through experience to see certain shapes as representing functions such as food, safe shelter, or the shadows of predators. Gibson’s work was aimed at practical applications; he developed principles for training military pilots during World War II. But photographers go through a similar kind of learning experience as pilots, learning to “fly” their cameras based on environmental cues. In their case, however, the affordances they learn to perceive are not functional, but expressive. And these affordances generally relate to an image of the thing, from some particular vantage point, in some particular lighting condition – not the thing in itself.

Gibson described affordances as perceived properties of environmental features, like rocks (being projectiles) and trees (being climbable). But to use the concept of affordances in photography, we need to see many of them as the result of dynamic physical *relationships* – object to camera, and object to light sources. All of the Gestalt principles I described earlier (proximity, symmetry, angularity, closure, and so on) can be thought of as affordances, to be used for expressive purposes. These expressive affordances are effects that can be caused by the photographer’s behavior in the process of exploring the environment, whether through moving the camera, moving objects and people in front of the camera, or moving the light sources illuminating the shot.

The simplest of these expressive affordances are related to the relative positioning of the camera. A camera location close to a subject suggests paying more attention to it than a camera location farther away. Looking down at people makes them look smaller and less powerful, while looking up at those same people makes them seem bigger and stronger. And if the camera is twisted somewhat off of horizontal, the audience will subconsciously feel an urge to brace themselves against falling over. Gliding slowly through space suggests a relaxed, dreamlike quality. Moving rapidly and violently suggests running, which can be fearful or joyous. Many of these perceptions are thought to be based on childhood memories – our earliest perceptual patterns (Lakoff and Johnson, 2000). These simple changes in positioning are the basis for imbuing the subject with varying degrees of energy and balance.

Other common expressive affordances are related to light and color. The face of an actor who is partially illuminated and partially in the dark may suggest a person doing some soul-searching, or perhaps a person who's hiding. People bathed in warm-colored light are more easily seen as happy or cheerful, while those bathed in cooler colors may look sad or fearful. The angle of the light can also bring out textural patterns on rough surfaces. For example, we see more clearly in noonday light, when the overhead sun illuminates things evenly in all directions. But we see more emotionally in early morning or late afternoon light, when shadows are long, and contrasts more extreme.

Novice cinematographers tend to avoid such factors in their movies, because the complexity they add seems like noise, much like the radio in my driving example. Looking through the camera, they're thinking about the things in the environment, not the picture of those things on the camera's viewfinder; and the complexity of shadows and textures is not seen as valuable. Experienced cinematographers, on the other hand, make use of complexity in expressive ways, and move through space seeking it out.

There is a relationship between the visual complexity in a motion picture and the viewer's sense of engagement. When we make the viewer's brain work a little harder to acquire an image, we often produce an increased desire to watch. For examples of this, watch the typical newscast on CNN, with an eye to the amount of movement and change presented. Certainly, some of it is there to inform; but a lot of it is there simply for sensory stimulus, creating a sense of dramatic tension. There is an interesting paradox here – by including more complexity (within reason, of course), the cinematographer reduces the audience's awareness of the screen itself, resulting in the sense of presence in the viewed environment (Botella, Baños, and Alcañiz, 2003).

Good photography characterizes a place or a person by the way it brings the audience's eyes to meaningful details and states of being. The essence of acting is in the actor's bringing the inner state of a character out into the open, where the audience can have an experience of that state in sight and sound. In my approach to cinematography, the camera is an actor, a co-conspirator with the people and things in front of it, conspiring to sell the audience on some feeling or point of view through visual rhetoric. The student learns to see expressively by searching for suggestive details, and moving the audience's eyes through the environment with varying qualities.

The very act of turning the motion picture camera on and off can be seen as a distortion of reality. If some real-world act, such as making a sandwich, takes five minutes to accomplish, then the simplest and most realistic vision of that act is to show it in its

entirety with a stationary camera. It's also the least engaging, because it doesn't differentiate between one moment and any other. Making the sandwich is one monolithic act, which the camera stares at impassively. But by selectively turning the camera off and on, the cinematographer excludes visual data that doesn't convey new information, focusing instead on just the salient details in the overall process being observed. Those details might include getting the bread, finding cold cuts in the refrigerator, spreading condiments, assembling the sandwich, etc. In this case, less visual data constitutes more visual information. The cinematographer is imposing a certain categorical sense in presenting the vision of what's there.

In addition, the cuts between shots increase the perception of visual energy. And by moving the camera in between shots, the cinematographer brings about new visuospatial configurations on the screen with each shot. When a new image is presented, the viewer's visual brain circuitry is forced to acquire and process an altogether different image, resulting in more visual work being done, with an attendant sense of higher energy, and greater engagement. In the opposite approach, shots may be slow-paced, but with the camera slowly drifting around. This sort of treatment is appropriate for a dream or a love story, as the viewers generally lose their sense of direction within the movie world, and feel somewhat adrift.

Conclusion

The journey from beginner to accomplished photographer is a long process, and one that varies considerably from student to student. All too frequently, the focus in the classroom is on the content of movies, and the technology of the camera and editing system, rather than on cultivating visuospatial sensibilities. What ends up on the screen is just the end product, after all – the heart of cinematography is learning the language of moving pictures. For the beginner, the productions underlying this language are not composed of scripts and actors, but rather patterns of behavior and perception that must become somewhat automatic before “good” movies can be created.

Constructivism makes an excellent guide for the instructor, in that it emphasizes self-directed exploration over lectures on the “right” ways to do things from the teacher. Students learn to communicate by guiding the audience's eyes through space, and managing their perceptions over time; and their expressive skills emerge gradually through experience. Not only do students gain the ability to create their own movies, but they gain insight into why they like the movies that they do, and how television commercials influence their perceptions of products.

About the Author

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References

- Arnheim, R. (1974). *Art and visual perception: a psychology of the creative eye* (2nd ed.). Berkeley: University of California Press.
- Baecker, R., & Posner, I. (1999). Children as digital motion picture authors. In Druin, A. (Ed.), *The design of children's technology*. San Francisco: Morgan Kaufman.
- Bogart, A., & Landau, T. (2005). *The viewpoints book: a practical guide to viewpoints and composition*. New York: Theatre Communications Group.
- Botella, C., Baños, R.M., & Alcañiz, M. (2003). A psychological approach to presence. Presented at PRESENCE 2003, 6th Annual International Workshop on Presence. On-line at: <http://www.presence-research.org/papers/Botella.html>
- Cox, M. (2005). *The pictorial world of the child*. Cambridge University Press.
- Davis, B., Sumara, D., & Luce-Kapler, R. (2000). *Engaging minds: learning and teaching in a complex world*. Mahwah, NJ: Lawrence Erlbaum.
- Fischer, K., & Rose, S. (1994). Dynamic development of coordination of components in brain and behavior: a framework for theory and research. In G. Dawson & K. Fischer (Eds.), *Human behavior and the developing brain* (pp. 3-66). New York: Guilford Press.
- Flusser, V. (1984). *Towards a philosophy of photography*. University of Chicago Press.
- Freedberg, D., & Gallese, V. (2007). Motion, emotion and empathy in esthetic experience. In *Trends in Cognitive Sciences*, 11 (5), pp. 197-203.
- Gibson, J. (1977). The theory of affordances. In R. E. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing*. Hillsdale, NJ: Erlbaum.
- von Glasersfeld, E. (1996). *Radical constructivism: a way of knowing and learning*. London: Routledge.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: the embodied mind and its challenge to western thought*. Jackson, TN: Basic Books.
- Maturana, H., & Varela, F. (1992). *The tree of knowledge: the biological roots of human understanding*. Boston: Shambhala.
- Neisser, U. (1989). Direct perception and recognition as distinct perceptual systems. Presented at the Annual Meeting of the Cognitive Science Society, Ann Arbor, MI.
- Palmer, S. (1999). *Vision science: photons to phenomenology*. Cambridge, MA: MIT Press.
- Piaget, J. (1954). *The construction of reality in the child* (M. Cook, Trans.). London: Routledge and Kegan Paul.
- Riva, G., & Waterworth, J. (2003). Presence and the self: a cognitive neuroscience approach. In *Presence-Connect*, 3 (3). Online at: <http://www.presence-connect.com>.
- Strommen, E. (1988). A century of children drawing: the evolution of theory and research concerning the drawings of children. *Visual Arts Research* 14, pp. 13-24.
- Waterworth, J. A., Waterworth, E. L. & Westling, J. (2002). Presence as performance: the mystique of digital participation. Paper presented at Presence 2002: Fifth Annual International Workshop on Presence, Porto, Portugal.
- Yan, Z., & Fischer, K. W. (2002). Always under construction: dynamic variations in adult cognitive development. In *Human Development*, 45, 141-160.