

Original Research

Cognitive Schemes and Scripts: Research Evidence from Children's Drawings

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Abstract

Children and adults unconsciously organise their knowledge and memory about things into schemes and scripts. This paper presents selected data from four research projects that explore these two theoretical perspectives through the medium of eight children's drawings. The paper concludes that while script and scheme theories of cognition do not provide a complete account of cognitive progression, they nonetheless have relevance for educators in understanding the cognitive frames of reference children draw upon which in turn, help to explain the diversity in children's thinking.

Key Words: Cognition; drawing; script; scheme

Sorting Out the Terminology: Schemes and Schema

Decades ago Piaget defined schemes as both internalised behavioural patterns and mental understandings (Piaget, 1963). An example would be the infant's looking scheme which is established once a baby learns from experience to use vision systematically to search for something specific, as opposed to looking indiscriminately at everything (Ginsburg & Opper, 1988). With regard to older children, Piaget was interested in the mental schemes that developed in response to environmental challenges. This led him to investigate how concepts about mass and length for example, related to abstract understandings such as conservation.

Piaget's term 'scheme' was initially translated into English as 'schema' and 'schemata' (plural) but he himself was not happy about this. Piaget and Inhelder (1969) described a scheme as an active organisational network of understanding similar to a principle that once acquired, is then used as a basis for further action or understanding. As such they argued schemes become more elaborate with age. Piaget also used the term to refer to internalised behaviour and action patterns. Consequently a scheme in the Piagetian sense refers to the development of conceptual networks and describes a cognitive process. As far as Piaget and Inhelder were concerned a schema was different to a scheme, the former merely being a reduced or simplified image, a figurative representation of reality such as when a picture of an orange is used to represent the word or symbol 'orange.'

Today the concept of a scheme retains much the same meaning as when Piaget originally defined it, but newer theoretical debate about cognition has given the notion a stronger prominence and greater applicability to developmental issues (Barret & Light, 1976; Bjorklund, 2005; Fischer & Biddell, 1998; Flavell, Miller & Miller, 2002; Meadows, 2006). The work of Bjorklund, and Fischer and Biddell for example emphasised the importance of progressive schematic development towards higher order thinking. Meadows acknowledged its necessity in the development of categorical, operational reasoning.

Schematic theory has also become incorporated in research on children's drawings (for example Anning & Ring, 2004; Boyatzis & Eades, 1999; Lambert, 2005b; Nutbrown, 1999; Watson & Schwartz, 2000). Anning and Ring's work along with that of Nutbrown was based upon an assumption that schematic frameworks underlie children's drawings and the topics they select to draw about. Nutbrown interpreted schemes as patterns of learning and thinking, hence the title of her book *Threads of Learning*. Watson and Schwartz considered some previous studies where the role of schemes was seen to have relevance for the development of drawing styles in children, and the Boyatzis and Eades and Lambert studies acknowledged schemes in their investigations of gender differences found among the topics young children chose to depict.

Today it could be said that 'scheme' or 'schema' (either term can be found in current literature and are used interchangeably), refers to an internalised framework of information about a specific topic or event. Schemes influence the way we encode, make inferences about and retrieve information. They also make it possible to fill in the gaps when we are trying to retrieve knowledge but do not have all the facts needed. This in turn means that schemes can provide both correct and incorrect information. For early childhood educators, schemes are important as a means of understanding how a child makes sense of new knowledge or reacts to new situations. Gaining an insight into a child's cognitive schemes also assists understanding diversity among learners.

Schematic Theories and Drawing

Schematic thinking provides a large part of the cognitive framework younger children use when drawing, whether recalling past events (Gross & Hayne, 1998; Lambert, in press (a); Oppawasky, 1991) or thinking futuristically and imaginatively. The role of scripts and schemes in memory recall emanates from the work of cognitive psychologists who argue that over time, script based memory generalises into a form of event memory as event representations are accumulated (Bjorklund, 2005; Nelson, 1986). Even when thinking futuristically and imaginatively, young thinkers still draw upon schemes and scripts, often as a starting point or as intermittent points of reference. These schemes then become integrated into the processes of making inferences and drawing upon conceptual frameworks as verbal and non verbal forms of expression develop (Meadows, 2006).

This paper presents a synopsis of data from a purposive sub-sample, collected during the course of four research studies about drawing and cognition with children aged between four to five years six months in rural New South Wales (Lambert, 2005a; 2005b; in press (a); in press (b)). Data were collected during the children's last six months at preschool and their first six months at school and is in the form of children's drawings as presented in Illustrations 1 to 9 following. The research question guiding this explorative study was: how are cognitive schemes and scripts manifested in preschooler's drawings?

The sub-sample of drawings for this study was drawn from a data base of 500 drawings from previous studies as noted above. This purposive sample was selected on the basis that the drawings illustrated distinctive schematic frameworks that could be compared and/or that illustrated scheme-to-script progression.

Illustrations 1 to 4 following, present the drawings of four children about the Cinderella story after having had it read to them as a small group. The children – two boys and two girls - were aged four years and nine months to five years and three months, and all were in the first few months of primary school.

ILLUSTRATIONS 1 - 4.



In recalling the story diagrammatically these four children focussed on different aspects of it due to the fact that each individual selected the most salient features about it from their own schemes and then used these elements to reconstruct the story. The inclusion of four drawings is necessary to illustrate the schematic range that can occur and the nature of individual diversity this can encompass.

Gibson's (1979) ecological theory of visual perception provides a useful interpretative framework here and also, another theoretical link between schematic thinking and drawing. Gibson emphasised the selection process the drawer uses as a core cognitive activity and acknowledged this as a basis from which to analyse children's drawings. He identified the salient elements that were selected as invariants. Given that the process of selecting invariants to depict is voluntary, it can be assumed that the resulting drawing represents things that matter most to the drawer. One could argue therefore that this process is a subjective one and as such is likely to be related to the dispositions of the drawer, among other things. The work of Perkins, Jay and Tishman (1993) on dispositional cognition (see also Tishman, Perkins & Jay, 1995), is relevant here. These researchers describe the integrative role that ability, sensitivity and inclinations play in what they term as "good thinking" (1993, p. 3). With regard to drawing, dispositional factors have been found to be relevant when drawing is used as an aid to problem solving (Lambert, in press (b)) and in the use of event memory (Gross & Hayne, 1998; Lambert, in press (a)).

These four drawings provide a clear demonstration of the situation-specific or domain-specific nature of schemes, the individuality of the drawer in terms of the salient elements they choose to depict, and the role of drawings as diagrammatic representations of children's memories about events. They reveal variance among the things that each child considered to be important about the story of Cinderella. For educators this raises questions about the likely degree of variance that could occur among children's perceptions of what is salient when engaged in learning. This issue however can only be raised hypothetically as it was not examined in the present study. Illustrations 5 and 6 that follow provide a different focus on schemes as intellectual frameworks. They illustrate cognitive schemes as a reflection of the socio-cultural contexts young children grow up in, which in turn provide scaffolding for their drawings and other kinds of symbolic play.

ILLUSTRATION 5.

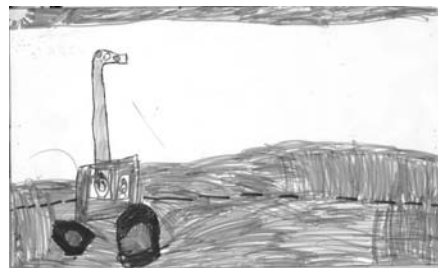
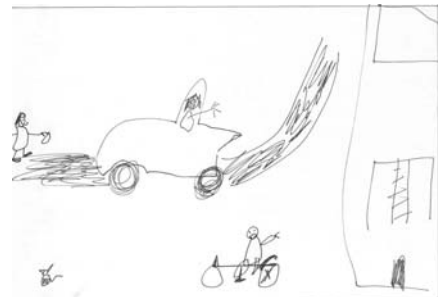


ILLUSTRATION 6.



As with Illustrations 1, 2, 3 and 4, Illustrations 5 and 6 show that different schemes were used to depict the same experience. But in these examples each drawing also reflects the

family and community context each child lived in. Both these drawings are about going to the local Noah's Ark indoor gym. It is important to note that both children were asked to draw this as an imagined event rather than an actual, past experience. Mitchell (4.9 years) (Illustration 5) grew up on a farm and his drawing shows that his view of family transport to Noah's Ark is a tractor. Home transport to Mitchell consists of various kinds of farm vehicles, even the 'family car' is an old dual cabin, Toyota four wheel drive with an open tray on the back which everyone in the family calls 'the truck.' Added to this is the fact that for Mitchell's family, most driving occurs out of town on roads that have a very low volume of traffic. On short trips they may not see vehicles until their local village is reached. Alternatively the other vehicles they do see are often farm machinery such as harvesters, tractors, graders and trucks.

Brad (4.6 years) on the other hand (Illustration 6) lives in the suburbs of a much larger country town and his idea or scheme for vehicles is quite different. Brad does not often see many farm vehicles in town but as his drawing indicates, he usually sees plenty of other things as he is exposed to higher volumes of traffic that include people, pets and bike riders. Thus, each child's family and neighbourhood experiences contributed to their scheme development that in turn provided the scaffolding for their drawings of this imagined event.

The Role of Cognitive Scripts

As noted earlier, today the terms schema and scheme are often used interchangeably and depending on the particular theorist whose work one happens to be reading, their meanings can vary slightly. Increasingly they are found alongside the mention of script theories of cognition, in fact it seems at times that the three words are used interchangeably but to include 'scripts' under this umbrella is not correct. Scripts are abstract networks of understandings about past events and could thus be said to typify domain specific knowledge (as do schemes). They include temporal as well as causal elements however and are therefore sequential by nature (Flavell, Miller & Miller, 2002; Nelson, 1986). If for example a young child was describing a bus ride and drawing upon a script to do so, his/her comments would describe the event sequentially 'Well, first we waited at the bus stop then when the bus came we had to wait our turn to get on. Mummy gave the driver our money and the driver let me have the ticket. Then we went down the bus to find some seats . . .'" Consider also the experience many parents have had of being told by their five year-old that nothing happened at school. What the child is really saying is that nothing unusual happened. School children quickly form scripts for daily school life, but if nothing different occurs, the question "What happened at school today?" does not activate the use of the relevant script because the script for that day has remained unchanged.

How Do/Don't Schemes and Scripts Relate to One Another?

Theoretical discussion about cognitive scripts originated under the information processing (IP) umbrella due to the fact that scripts describe memory development. However IP theory on the workings of long and short term memory presents as a structured linear flow model and as such is not really applicable to the shifting, inconstant cognitive style of very young children. Fortunately in more recent times, the notion of scripts has been adapted to a range of theoretical perspectives thus enabling a more diverse applicability to children's thinking.

What is the relationship of schemes to scripts? Put simply it could be said that script memorisation is partly based on the incorporation and building up of schemes over time. During this process, memory about events becomes internalised and concept development is consolidated although it should be remembered that schemes can also exist as independent

units of understanding in their own right (Nelson, 1986). For the purposes of this article, the term 'schematic knowledge' will be used to refer to schemes and scripts together.

Developmental links between schemes and scripts occur early in life. The work of Jean Mandler on infant cognition best illustrates this. Mandler (1992) described infant cognition in terms of conceptual primitives which refers to the building of conceptual knowledge over time via image-schematic formats, not dissimilar to schemes. As one would expect in children this young, emphasis is on the transference of perceptual knowledge into concepts. Mandler argued that observation or 'the visual' (and the resulting schemes that develop) contributes substantially to script and concept development, rather than the physical manipulation of objects alone and that concept development therefore occurs alongside sensory motor experiences rather than after them.

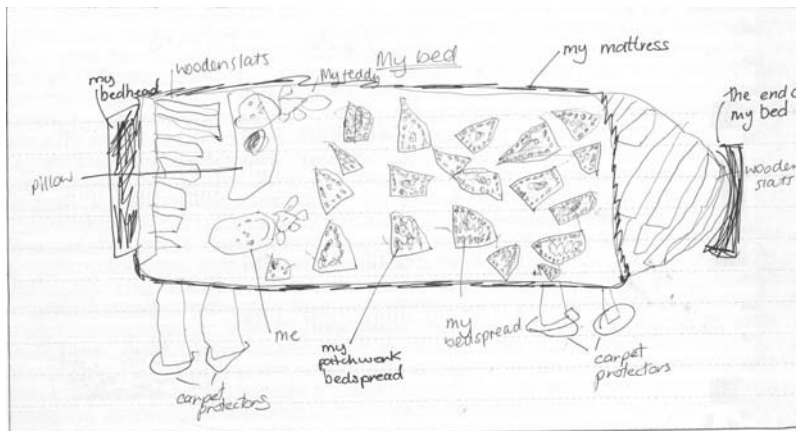
Illustrations 7 and 8 demonstrate how with increased life experience, a cognitive scheme may develop into a script. The two pictures below were drawn by Montanna. Illustration 7 was drawn when she was four years and four months and Illustration 8 when she was five years and seven months. The topic of both these drawings is her bed.

ILLUSTRATION 7.



I'm in my bed tonight but this is my new bed (she actually meant 'last night.')

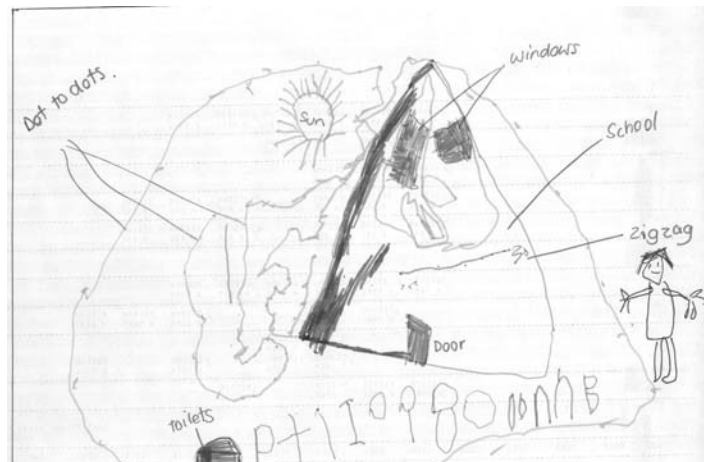
ILLUSTRATION 8.



Dad had to fix my bed 'cos Hannah jumped on it. First we had to pull the doona off and then the sheets and pillows. Then Dad and Em put the slats in other spots and fixed them there. Dad made a new slat for the last one 'cos that one got broken. Then mummy and me slipped the plastic things under the legs. (See 'carpet protectors' on the illustration). I helped put clean sheets on and then we put my summer bedspread on 'cos I didn't want the doona on any more and I didn't want my blanket underneath the doona. Then I put my toys in their special place and then I got on myself, last of all on the top.

Montanna's awareness of what constitutes her bed is far more sophisticated in the second drawing and her knowledge of it demonstrates a cognitive script. This can be seen by the fact that her drawing provides an x-ray view of the layers that simultaneously exist on the bed and her dialogue recounts her experience in the order in which it happened. In contrast to this complexity, her drawing of the bed when it was new 15 months previously (Illustration 7) consisted of a simple profile outline with virtually no detail. This was despite the fact that she helped her father put the bed together when it was new, and had then been exposed to a similar ritual as when the bed was mended, but in reverse order. As such Montanna's first drawing showed a reductionist view of form, more typical of the early stages of scheme formation. Illustration 9 (below) provides another example of a child's script, this time in relation to a day at school. Note the chronological sequencing of events as the child talked about it.

ILLUSTRATION 9.



Here am I going into school, it's early morning and there's the sun. I cross the courtyard (points to 'zig zag') and here's where I go into my classroom (points to 'door'). After the morning we move and we read by the window' (points to the windows). We have our big lunch on this side (points to the 'dot-to-dot' area) and the toilets are there too. We do lots of play before the big kids come out and then cos we're tired we go back in here to rest. (Points to 'door' again.)

Educational Implications of Scheme and Script Interpretations of Cognition

Arguments for Adopting Schematic Interpretations of Cognition

Schemes, by the nature of their specificity as domain specific knowledge, help us to distinguish between the expert and the novice as Chi's (1985) research investigating a four and one-half year old dinosaur expert, illustrated. This child was familiar with more than 40 kinds of dinosaurs and was able to hierarchically classify 20 of them which is more typical of the cognitive abilities of an adult than a preschooler. Chi's research demonstrates that when young thinkers have the disposition to explore a favourite area of interest in depth and over time, they can become an expert in that knowledge domain and develop complex schematic frameworks. The word disposition here refers to Perkins, Jay and Tishman's theory (1993) of dispositional cognition where the spheres of cognitive ability, sensitivity to the issue and inclination to investigate it are integrated. For educators of young children, this emphasises the value of not just getting to know children's favourite interests but ascertaining the cognitive frameworks (schemes or scripts), that underlie them so that one can know how to link into them and extend them into higher order thinking skills.

Schemes can be useful in decoding texts such as narratives, theatre, television, and other screen media and books, thereby having relevance to how children use multi-literacies to negotiate and construct meanings (Cope & Kalantzis, 2000). However when using texts with the express purpose of fostering "good thinking" (Perkins, Jay & Tishman, 1993, p.3), preschoolers will need support to acquire the kinds of strategies that can assist the decoding process. The following two paragraphs explain this further.

The importance of acknowledging prior knowledge is highlighted when schemes and scripts are used as a frame of reference to both understand and extend children's thinking. Prior knowledge is the basis for schematic development, consequently educators need to know how to activate this knowledge when introducing new learning experiences if meaningful links and feedback loops are to be successfully scaffolded into more advanced thinking. This means much more than merely knowing what children's interests are. It means being able to link children's dispositions towards learning with their domain specific knowledge (this is yet another way to describe schematic knowledge) so that complex understandings progressively develop. This involves being able to facilitate the integration of motivational, metacognitive and domain specific knowledge. Whilst not the focus of this study, this is however a critical issue in relation to early childhood curricula and a detailed discussion can be found elsewhere (Lambert & Clyde, 2000).

Metacognition has an important role to play with regard to how children apply their schematic knowledge. Preschoolers can be metacognitive (Lambert, 2001; Schneider & Bjorklund, 1992), but they need assistance to consciously use metacognitive strategies (Siegler & Alibali, 2005). Knowing how to use them enables more efficient recall of and connections among schemes and scripts which in turn promotes deeper learning. A good metacognitive strategy can be as simple as knowing to pause to consider the picture or title of a story so as to orientate oneself to the topic before attempting to read it. Cognitive tricks such as this contribute to the construction of more complex schematic frameworks and thus, higher order reasoning.

When planning educational programs, teachers should find that acknowledging the schemes and scripts children use also fosters a better understanding of diversity. This occurs because having an understanding of the contexts that children grow up in also means having an understanding of the schemes that underlie their thinking. Illustrations 5 and 6 show the socio-cultural contexts that surrounded the two drawers of these scenes. This is particularly

so when considering cultural differences. The role of drawing here can be especially useful when providing learning experiences for non or partial English speakers because it lessens the emphasis on English as a vehicle for reasoning, yet still allows the drawer to demonstrate his or her schematic knowledge.

Although the data presented in this paper focuses on the individual drawer, exploring schemes and scripts through socially scaffolded drawing experiences would make a further contribution to our understanding of children's scheme construction and re-construction. Brooks (2005) is one of the few researchers to do this and has come to some useful conclusions regarding re-thinking the value of drawing across the curriculum. "When drawing is viewed as a tool that is part of a meaning-making repertoire it helps teachers to see drawing as part of a learning process, rather than as a product that is indicative of a more rigid stage of development" (Brooks, 2005, p.89). Perrin (1994) takes this further, suggesting that when the arts are balanced more equally with other curriculum areas, children's academic abilities should be expected to improve because the arts naturally foster active learning and the experimentation of ideas.

Arguments Against Adopting a Schematic Interpretation of Cognition

When our previous experiences are biased or incomplete so too will be the resulting schemes that evolve in our minds. This in turn, may adversely affect the acquisition of new knowledge by drawing on "imprecise, partial and idiosyncratic understandings" (Driscoll, 1994; p.152) and illustrates the point that not all schematic development is positive or useful. Once again this emphasises the need to become acquainted with the contexts in which children grow up and thus, to develop an insight into the kinds of schematic frameworks children have developed in order to better recognise both the gaps and strengths in their knowledge.

The over reliance on schematic functioning as an interpretation of cognitive development is problematic due to the situation-specific nature of schemes, particularly so when the generalisation of knowledge becomes important. This is because schematic knowledge is tied to the specific situations in which it occurs; consequently it may not always be accessible across contexts. Baine and Starr (1992) argue strongly that concept generalisation does not occur automatically and note that problems in this area frequently happen within the early childhood period. Given that early childhood is the time when foundational learning is occurring, the issue of the generalisation of new knowledge is an important one. Implicit to this argument is the need to support the traditional, active learning and learn-through-play philosophy that underlies early childhood education so as to minimise any likely shift to more rigid program approaches. Active, hands-on learning experiences that occur through play contextualise new learning meaningfully for younger children thereby contributing to higher motivation and the disposition to generalise that knowledge to other situations.

Conclusion

The notion of cognitive schemes and scripts provides a sound although partial explanation for how children interpret what they know, as the drawings in this article have demonstrated. Although the terms schema theory and script theory appear in the literature, it should be noted that they do not constitute a theory in the traditional sense (Thomas, 2005). However this is not important, the key thing is that theoretical perspectives about schemes and scripts offer interesting dimensions to understanding cognition that deepens existing theories and debate. Moreover, it is the challenge of how to access manifestations of children's schemes and scripts that is of importance to educators. Here the role of drawing has much to offer but

so too have drama, mime, dance, music and movement, all highly symbolic and all capable of being used across the curriculum as windows into children's thinking.

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