Thirty years of illness scripts: Theoretical origins and practical applications

EUGÈNE J. F. M. CUSTERS

University Medical Center Utrecht, The Netherlands

Abstract

Aim: This study describes the introduction and spread of the concept of "illness script" in the medical education literature.
Method: First, I will concisely discuss the development of the "script" concept in the general psychological literature and the results of the studies performed to provide it with the necessary empirical basis. Next, I will sketch how "scripts" entered the medical domain via efforts to develop diagnostic systems in the field of artificial intelligence. Subsequently, I will describe how the illness script concept was elaborated and specified by medical educators and educational researchers.
Results and discussion: The illness script concept has solid underpinnings and can be used to elucidate aspects of medical expertise development. It can also be used to formulate recommendations for clinical teaching and has yielded a specific test, the Script Concordance Test.

Introduction

Since Bartlett (1932/1954) experimentally demonstrated that humans do not literally remember real-world knowledge, such as stories, but recollect them by their gist and are inclined to make them shorter and more coherent than they initially were, the concept of a "schema" has been used to represent the basic units people use to remember these gists (Bobrow & Norman 1975; Brewer & Treyens 1981; Mandler 1984; Schmidt & Sherman 1984). A more specific type of schema, a *script*, has been proposed as the knowledge structure that represents generalized events as a unit (Abelson 1975; Schank & Abelson 1977). In the years following the publication of the Schank and Abelson (1977) work, several researchers have investigated the representational characteristics and behavioral aspects of scripts (Graesser et al. 1979; Bellezza & Bower 1981; Smith & Graesser 1981; Walker & Yekovich 1984; Abbott et al. 1985; Yekovich & Walker 1986; Maki 1990; Davidson 1994). Although full agreement concerning the details of scripts is lacking, the following seven aspects can be considered a common denominator: Scripts are (1) high-level, pre-compiled, conceptual knowledge structures, which are (2) stored in long-term memory, which (3) represent general (stereotyped) event sequences, in which (4) the individual events are interconnected by temporal and often also causal or hierarchical relationships, that (5) can be activated as integral wholes in appropriate contexts, that (6) contain variables and slots that can be filled with information present in the actual situation, retrieved from memory, or inferred from the context, and that (7) develop as a consequence of routinely performed activities or viewing such activities being performed; in other words, through direct or vicarious experience (Abelson 1975;

Practice points

- "Script" is a psychologically validated concept to represent knowledge in real-life domains.
- "Illness script" is a specific script format geared to represent patient-oriented clinical knowledge organized around Enabling Conditions, Fault (the pathophysiological process), and Consequences.
- Illness scripts enable the clinician to represent general disease knowledge as well as memories of specific patients in the form of instantiated illness scripts.
- The illness script theory provides clues for clinical training and has brought forth a specific test, the "Script Concordance Test".

Schank & Abelson 1977; Haberlandt & Bingham 1984; Pryor & Merluzzi 1985). Some important functions are served by scripts: (1) they provide structured knowledge necessary for understanding behavioral sequences, (2) they enable individuals to integrate new incoming information with existing knowledge, (3) they guide memory retrieval, (4) they enable predictions about what will happen in the near future, (5) they guide actual behavior, and (6) they usually contain knowledge that can be used to explain why a specific action or sequence of actions has occurred or might occur.

Most of the times, scripts are activated if the individual is in the appropriate context or if this context is being mentioned or thought of. The classic example is the "restaurant script." Upon entering a restaurant, or thinking about a restaurant, the restaurant script is activated and the individual uses it to

Correspondence: Eugène J. F. M. Custers, Ph.D., University Medical Center Utrecht, School of Medical Science, Center for Research and Development of Education, HB Building 4.05, P. O. Box 85500, 3508 GA Utrecht, The Netherlands. Tel: 31 88 75 56793; E-mail: ecusters@umcutrecht.nl

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understand what happened and predict what will happen next. The script contains central or core information, e.g., that food is being served in exchange for money, whereas other aspects may be more variable or peripheral, for example, whether there will be a waiter or the food will be taken by the customer from a counter, and whether an appetizer will be served or not. If a script is activated, its central aspects will become available in a fixed manner, while less central aspects will have the form of variables or slots that might be filled in using actual information available in the context (e.g., that the waiter is a young woman) or by default (e.g., that the customer can choose entries from a menu). Not all slot information or variable values will be inferred by default; some will simply be left unspecified but open to be filled-in at some point during the completion of the script (e.g., whether an appetizer is offered). The process of assigning values to variables and filling slots with actual information from the context, information retrieved from memory, or by default, is called the *script instantiation*. An instantiated script can be seen as the representation of a concrete event, with part of the knowledge in the representation supplied by the generic script, and part by situation-specific information, which may be actually present or inferred at the spot. In instantiated scripts, this situation-specific information is "tagged" to the generic script (Schank & Abelson 1977; Graesser et al. 1980; Bellezza & Bower 1981; Schmidt & Sherman 1984; Maki 1990; Davidson 1994), and if the instantiated script is stored in long-term memory, the tags enable the individual to remember it later as a specific event that actually took place. However, unlike the generic script, tagged knowledge will gradually decay over time; hence, with the passing of time, specific event memories will be increasingly dominated by knowledge of the generic script, which is a much more stable representation in memory. Thus, if we retrieve such memories after a long time, we might no longer be able to remember most details of the instantiated script, unless they were very salient or interrupted the script's progress (e.g., the time when we had to leave the restaurant before finishing dinner because smoke filled the room – something we may remember even after many years).

The psychological validity of scripts

A large number of studies have provided evidence for the psychological validity of the script concept. To begin with, there is ample evidence that people organize familiar events in a hierarchical structure with causal or temporal connections between individual events and scenes (Rosch 1978; Bower & Clark-Meyers 1980). In addition, agreement has been found not only with respect to which actions belong to a script (e.g., Bower et al., 1979; Graesser 1981), but with respect to sequence, centrality, and distinctiveness of these actions as well. Moreover, the events that compose a script are temporally cued, i.e., it is generally much easier to tell a sequence of events in forward order than in reverse order (Haberlandt & Bingham 1984; Barsalou & Sewell 1985).

In addition, in laboratory experiments, script theory specifically predicts differential memory performance for (a) different types of information (i.e., typical versus atypical), (b) differential relevance of information (i.e., important versus unimportant), (c) different retrieval tasks (i.e., recall versus recognition), and (d) different delays of retrieval (i.e., immediate versus delayed memory test) (Sulin & Dooling 1974; Tzeng 1975; Bellezza & Bower 1981; Smith & Graesser 1981; Yekovich & Walker 1986). For example, recall studies have shown that at immediate testing, atypical script actions, objects, or events are recalled quite well, while at delayed testing, memory for atypical information appears to have faded, particularly if this information is less salient, relevant, or vivid (Bower et al. 1979; Graesser et al. 1980; Graesser 1981; Smith & Graesser 1981; Schmidt & Sherman 1984; Davidson 1994). Memory for script typical information, in contrast, is featured by recall intrusions, that is, this information is "recalled" even if it was not present in the instantiated script (Brewer & Treyer 1981; Schmidt & Sherman 1984). In recognition memory studies, the corresponding phenomenon of false alarms to (deliberately omitted) script typical information is an ubiquitous finding (Sulin & Dooling 1974; Bower et al. 1979; Graesser et al. 1979, 1980; Bellezza & Bower 1981; Brewer & Treyens 1981; Walker & Yekovich 1984; Nakamura & Graesser 1985; Nakamura et al. 1985; Yekovich & Walker 1986; Maki 1990; Davidson 1994). False alarm rates to atypical information, in contrast, are much lower, in particular, if this information is peripheral to the script (Nakamura & Graesser 1985; Yekovich & Walker 1986).

In addition to recognition memory performance, script theory also makes predictions about information processing and decision speed, expressed as reading speed or decision reaction times (RTs). In its most general form, the reasoning behind this is quite simple: new information that an individual will expect, because it is implied by the script or can easily be inferred from the script, will be processed faster than unexpected information. Thus, if a restaurant script is activated, the statement "The waiter was gentle" will be processed faster than "The repairman was gentle," even although in isolation these statements will show similar processing times. In the case of a specific script instantiation, however, predictions about processing times are a bit more complex. If, in a particular instantiation of the restaurant script, a repairman was present (e.g., doing repair work while we were eating), we may later have more vivid memories of this repairman than of the waiter, because we may have trouble discriminating between different instantiations of the restaurant script – in all of which a waiter was present, but in only one of these a repairman. More generally, script typical information will be easily and quickly inferred, but hard to recollect after some time, in particular, if the information is typical, but not absolutely necessary for the script. Thus, after a while, a question, such as "did you have an appetizer?" will be harder to answer – as evidenced by a longer RT – than the question "was there a repairman?" Laboratory studies have shown that indeed it takes more time to decide on the actual presence of typical features of a script in a particular instantiation than on the presence or absence of atypical features (Nakamura & Graesser 1985; Yekovich & Walker 1986).

Table 1. Example of a classic script story (left-hand panel) and an illness script story (right-hand panel).	
Jack decided to take his girlfriend, Chris, out for a nice dinner. He called a friend of his who recommended a good restaurant. He then went out to his car and drove over to Chris' house to pick her up. They drove to the restaurant and he stopped out in front. They got out of the car and let the valet park it. Then they walked inside and Jack confirmed their reservations with the hostess. They sat for a few minutes in the waiting area, and then the hostess escorted them to their table. After the waitress had introduced herself, they ordered cocktails. They browsed the evening paper for a while, and then looked at their menus. After they decided what they wanted to eat, they ordered dinner: Jack opted for a steak with pepper sauce, while Chris chose a lobster dish. As their food was being served, they placed their napkins in their laps. They enjoyed their meal, and had another drink. After dessert, Jack wanted to smoke a cigar, but the waitress warned him that they were sitting in the non-smoking area. When they were finished, Jack paid the bill, and left a generous tip. Then they walked out of the restaurant, got their car, and drove home (adapted from Graesser et al., 1979)	You are just about to have dinner, when you receive a telephone call from Mrs. Jones. She wants you to come immediately, because her husband ''is having it again'': he is rolling across the room because of the pain, and has vomited several times. Mr. Jones is a 47-year old store-keeper, who is married and has three teenage children. At age 30, he was treated for bronchitis. Six years ago, he had his leg broken as a consequence of a car accident. Four years ago, he was treated with medicaments for kidney stones. His older brother is known with coronary disease, while his father died at age 58 from a CVA. His 52-year old sister has diabetes mellitus. When you arrive at the Jones' home, Mr. Jones is sitting on the sofa, smoking a cigarette and recovering a bit; the pain has just subsided. He complains about having had a convulsive abdominal pain at the left side, just abreast of the navel; the pain extended to his groins. The pain emerged all of a sudden, and then gradually subsided; during the attack, he almost couldn't stand it. Earlier that day, he had remarked that his urine showed a red hue, but he had not paid much attention to it, because he had no pain at that time. His wife, who has measured his temperature, says he has a 38.2 °C

Illness scripts

At a superficial level, the analogy between "real life" scripts and "illness" scripts is obvious: most, if not all, diseases can be construed as a sequence of events occurring in a patient. The script, or generic event sequence, maps onto the general clinical picture of a disease, whereas each individual patient can be considered an instantiated illness script, with both typical (central) or atypical (peripheral) features, which appear in a certain order. To illustrate the analogy, Table 1 contrasts a real life script (the restaurant script; adapted from Graesser et al. 1979) with an illness script (a patient with a renal colic). At a deeper level, the central theme of both real life scripts and illness scripts is to provide a format to represent implicit causal coherence of knowledge (Schank 1975; Schank & Abelson 1977).

The concept of "script" was introduced in the medical literature by Clancey (1983) only a few years after the general script concept emerged in the psychological literature. "There are many kinds of infections, which have different characteristics, but bacterial infections tend to follow the same script: entry of an organism into the body, passage of the organism to the site of infection, reproduction of the organism, and causing of observable symptoms" he explained (p. 230). In addition to the obvious parallel with real life events, the script concept in the medical domain also appeared to nicely fill the gap between two existing views of medical diagnosis, one which emphasizes that diagnosis is basically a reasoning process (i.e., the use of biomedical knowledge to explain complaints, symptoms, and other findings in a patient), and one which conceives of diagnosis as a quick categorization process (i.e., the direct mapping of patterns of complaints and symptoms to diagnostic categories). In fact, the "illness script" as conceived by Feltovich and Barrows (1984) was particularly designed to connect the two approaches. They specified the illness script by distinguishing three main components, the Enabling Conditions, – i.e., the patient and contextual factors that influence the probability that someone gets a disease, such as age, sex, occupation, risk behavior, and hereditary factors, – the Fault, i.e., the underlying pathophysiological process, – and the Consequences, i.e., the complaints, signs, and

symptoms the Fault gives rise to (Feltovich & Barrows 1984; Custers et al. 1996, 1998; Hobus et al. 1987, 1989).

Especially in diagnostic situations, the Enabling Conditions play an important role, for it has been demonstrated that experienced physicians often arrive at the correct diagnosis quite early in the diagnostic process, on basis of only a few findings (Elstein et al. 1978; Hobus et al. 1987), and Enabling Conditions are usually the earliest available data. However, the patient complaint, which is obviously a Consequence, also plays an important role in illness script activation (Hobus et al. 1987). From a psychological point of view, early availability in the diagnostic process is more critical than a feature's role in the disease process. This can take unexpected forms, as in a recent study which reports that spontaneous smoking cessation can be an early sign of lung cancer, and could hence be viewed as an "Enabling Condition" from a diagnostic point of view, although few would endorse that smoking cessation enables the development of lung cancer, let alone causes it (Campling et al. 2011). In general, when asked to diagnose a case, experienced diagnosticians will use all the information available at a given moment, irrespective of its actual place is in the causal chain of events.

The notion that scripts are precompiled knowledge structures is also easily transferred to the illness script concept (Charlin et al. 2000, 2007). That is, novices (e.g., medical students) will rely more on their knowledge of the Fault, the underlying pathophysiological mechanism, in understanding disease and in diagnosing patients (Custers et al. 1998). With increasing experience, this form of "reasoning through" a case quickly becomes superfluous, as the steps in the reasoning chains become compiled. Thus, particularly in experts diagnosing routine cases, knowledge of the Fault only plays a minor role (Clancey 1983; Patel & Groen 1986; Boshuizen et al. 1988; Hobus et al. 1989; Norman et al. 1989; Boshuizen & Schmidt 1992). In this respect, illness scripts do not differ much from "real life" scripts: people can use underlying knowledge to explain a particular event or sequence of events, but they can basically learn the script without this knowledge, on the basis of experience alone (see Ahn et al. 1992, for examples of scripts that are learned without underlying knowledge). However, as experts' professional activities – in any domain

– not only include straightforward and routine diagnosis but also, for instance, providing interpretations, explanations, and judgments in a practical context, the possession of only "barefoot" scripts without underlying domain knowledge would not be sufficient for "true" expertise.

As yet, there is some evidence that memory phenomena found for everyday scripts also apply to illness scripts. For example, Arkes and Harkness (1980) found that symptoms that can be easily inferred from a diagnosis (i.e., typical symptoms), but are not presented in the case description, are often falsely recognized by diagnosticians. Furthermore, in a study investigating pediatricians' long-term retention of previous patients, Hassebrock and Prietula (1990) observed that participants had trouble remembering "actual" symptoms, but instead used knowledge of the disease to infer the clinical findings that presumably were present in the patient. Case features that deviated from the script, but had been, at the time, critical in establishing a diagnosis or installing a treatment, were better remembered. Thus, in script terms, these physicians remembered "tagged" atypical knowledge, but used the script knowledge to infer disease-consistent findings. Finally, concerning the processing characteristics of illness scripts, Custers et al. (1996) found that after an illness script was activated (by announcing the disease), prototypical case information was consistently processed faster than atypical case information, a finding that was replicated by Gagnon et al. (2006) and supports the notion of default values in illness scripts. Apparently, once an illness script has been activated, information that easily fits into the script slots can be processed faster than atypical information.

Illness scripts and the development of medical expertise

An obvious account of expertise development is to conceive it as experts having a larger repertory of schemas or scripts than non-experts (Rumelhart & Norman 1978; Glaser 1986; VanLehn 1989; Gilhooly 1990). Applied to the medical domain, this would imply that expert physicians have a larger repertory of illness scripts than less experienced physicians. But this is only part of the story; the structure and composition of individual illness scripts will also show expertise-related development. For example, Custers et al. (1998) showed that preclinical students, when asked to describe either the clinical picture of a disease or a typical patient with this disease, came up with more Fault-related knowledge (i.e., aspects of the pathophysiology of the disease) than residents and experienced physicians, who mentioned more Enabling Conditions (patient background information). Although medical students may basically have the relevant knowledge, their scripts will be less elaborately structured and not yet tuned toward use in practical situations. Experts are supposed to benefit from the integration and coherence script structures provide, in accessing knowledge for use in practice (diagnosis and treatment) as well as retrospectively (i.e., in recall). Indeed, studies have generally shown superior recall in experts for domain-related, relevant, or critical information (Spilich et al. 1979; Coughlin & Patel 1987;

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Hassebrock et al. 1993). In contrast, if the script structure is destroyed, e.g., by presenting information in a random, rather than in the appropriate sequential "script" order, this affects experts' performance much more than novices' – even to the point where experts no longer benefit from their expertise (McKeithen et al. 1981; Coughlin & Patel 1987; Norman et al. 1989).

Practical applications of the illness script concept

Taken together, theoretical considerations and practical research results suggest that a previous account of script development proposed by Schmidt et al. (1990) is in need of an update. In this view, the early stages of script development consist to a large extent of application of biomedical knowledge. Yet, even laypeople – who presumably have little biomedical knowledge – have knowledge of common diseases that is organized in structures that closely resemble illness scripts (Lau & Hartman 1983; Bishop & Converse 1986; Bishop et al. 1987; Becker et al. 2008). Rudimentary illness scripts can emerge on basis of very limited information addressed at a lay audience, like in health campaigns telling people how to recognize a stroke. During the early years of the medical course, by studying clinical textbooks students accumulate knowledge in a large number of different illness scripts. When they enter clinical practice in the clerkships, these illness scripts become gradually tuned to practice, i.e., they can be activated on basis of limited information available in a practical clinical context. This includes becoming sensitive to perceptual information that is available early in the diagnostic process. Illness script tuning depends to a large extent on this type of knowledge, i.e., the Enabling Conditions and the early available Consequences. "Once thought of, diagnosis was easy" was already a cliché quite a few decades ago (Wilkins 1970) and it suggests illness script development in this stage will benefit most from seeing a large number of patients with different diseases. Elaborate discussion of complex or "interesting" cases may be a useful instructional format – inevitably, practitioners will occasionally be confronted with patients who do not "fit" one of their illness scripts – but it will not contribute much to fostering illness script development in students. Similarly, role of knowledge of underlying pathophysiological mechanisms appears to be largely limited to understanding diseases at a deeper level, and occasionally to enable predictions about a disease's course or expected symptoms and laboratory values. Besides, this basic science knowledge will play an important role when experts disagree about a medical problem.

A few studies have investigated the practical effects of illness scripts, rather than its educational implications. Van Schaik et al. (2005) investigated the influence of illness scripts aspects, in interaction with physician characteristics, on physician referral decisions, whereas Monajemi et al. (2012) investigated the relationship between illness scripts and management plans. Besides, the illness script concept has also acquired a foothold in the general medical literature (Sanders, 2009, p. 28).

RIGHTSLINK

Finally, illness script theory has also brought forth an assessment tool, the Script Concordance Test (Charlin et al., 2000). This test measures to what extent a student's script matches that of a panel of experts by asking, in individual items, what the effect of a new piece of information (e.g., a new finding) would be on the likelihood of a given script. Thus, this test forces the examinee to carefully assess new incoming information, rather than "guessing" a diagnosis. This test, which is increasingly used in diverse clinical domains, appears to be particularly useful in ill-defined situations and has shown validity (Lubarsky et al., 2011).

Notes on contributor

EUGÈNE CUSTERS, PhD, is Medical Education Researcher, Center for Research and Development of Education, University Medical Center, Utrecht, The Netherlands.

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