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GETTING AND USING CONTEXT: FUNCTIONAL CONSTRAINTS ON THE ORGANIZATION OF KNOWLEDGE

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Studies of text comprehension (Bower, Black, and Turner 1979, Mandler and Johnson 1977, Schank and Abelson, 1977) have relied on the notion of a script or schema. A *script* represents world knowledge about common activities, events, and situations. It includes information about the components of these activities and the relations among the components. In this paper we examine scripts for common activities (e.g., cashing a check, or going to restaurants) as they exist prior to their instantiation in prose. The questions addressed in this paper are: How is the script knowledge structure accessed? and once the script is accessed how are its components made available? In other words, since context is so important in comprehension, we want to know how we get a context and once we have it, how does it help?

Schank and Abelson discuss how the script knowledge structure is activated during the comprehension of narrative. Clearly the easiest way to invoke a particular knowledge structure is to refer to it by name. Thus if the narrative explicitly mentions a situation, the retrieval of the knowledge structure should be straightforward. This can be done by a title of a passage, or by setting statements. We are interested in cases where the context is not given explicitly. Implicit reference to the activity can be made in a number of ways. For instance a goal mentioned in the narrative can serve as access cue for the script typically involved in accomplishing that goal. We are concerned with a different case where the presentation of one of the *actions* in the script leads to the accessing of the script itself. Thus on encountering the sentence:

John walked through the door

and saw the head waiter.

in a narrative, the restaurant script should be activated to contextualize subsequent sentences.

We test the claim that component actions will serve as access cues for their scripts if those actions are *distinctive* to the script. An action is distinctive to a script if that action is performed in few if any other scripts. Thus, for the restaurant script, the action SEE THE HEAD WAITER is highly distinctive, since it occurs in few if any other activities. The action of walking through the door occurs in so many activities that it is extremely low in distinctiveness to the restaurant script. This aspect of script structure has been developed and examined in Galambos, 1981 and 1982, and Galambos and Black, 1981.

We are also concerned with how the components of a script become available when the script is accessed. The question here is whether accessing the script makes all its components immediately available or whether some components have a more prominent status. In other experiments (Galambos and Rips, 1982), we have defined a measure of prominence called *centrality*. The centrality of an action is a measure of the importance of the action to the performance of the main goals of the activity. For example, in the restaurant activity the action EAT THE MEAL is highly central. Our hypothesis is that central actions should have a greater availability than less important actions when using an accessed context to aid comprehension.

Note that it is possible to select actions in such a way that these two dimensions are independent. The distinctive seeing the head waiter action is not particularly central to dining at restaurants, and the central eat the meal action is not particularly distinctive (since eating can occur in many other contexts; a plane, at home, a picnic, etc.). In terms of these dimensions our hypotheses are that the distinctiveness of an action should determine whether or not the script is accessed. The centrality of an action should influence whether the action becomes available when the script has been accessed. We designed a reaction time experiment in order to test these hypotheses.

The subjects' task was to decide whether or not two presented action phrases were components of the same activity. The first phrase was presented on a CRT screen for 1500 msec. This phrase then disappeared, and the second phrase was presented. The second phrase remained on the screen until the subject responded. The response latency was measured from the onset of the second phrase to the subject's response.

Four actions from each of 22 activities were chosen to sample the combinations of high and low levels of both centrality and distinctiveness. Thus from each activity one action (Hi-C/Lo-D) was high in centrality in the activity and low in distinctiveness, a second action (Lo-C/Hi-D) was low in centrality and high in distinctiveness. The third action (Hi-C/Hi-D) high in both centrality and distinctiveness, and the fourth was Lo-C/Lo-D. For example the four actions selected in the activity of cashing a check were:

Action Type	Action
Hi-C/Lo-D	write your signature
Lo-C/Hi-D	record the amount
Hi-C/Hi-D	go to bank
Lo-C/Lo-D	wait in line

Twelve pairs of actions were constructed for each activity by combining the four types of actions in all pairs at each order. These twelve conditions were equated for length and word frequency. The sequential presentation order of the two actions matched the real order of the actions for exactly half of the trials in each condition.

Stimuli were constructed for each subject so that all 12 conditions and all 22 activities were equally represented, but each action was presented only once. There were an equal number of negative trials using actions not involved in the positives. Twenty-four Yale undergraduates participated in the experiment.

The mean RTs for each of the twelve (positive) conditions were:

Condition	Mean
Hi-C/Hi-D --> Hi-C/Lo-D	873
Lo-C/Hi-D --> Hi-C/Hi-D	880
Lo-C/Hi-D --> Hi-C/Lo-D	964
Hi-C/Hi-D --> Lo-C/Hi-D	896
Hi-C/Hi-D --> Lo-C/Lo-D	1059
Lo-C/Hi-D --> Lo-C/Lo-D	963
Hi-C/Lo-D --> Hi-C/Hi-D	986
Hi-C/Lo-D --> Lo-C/Hi-D	1124
Hi-C/Lo-D --> Lo-C/Lo-D	1081
Lo-C/Lo-D --> Hi-C/Hi-D	1193
Lo-C/Lo-D --> Hi-C/Lo-D	1013
Lo-C/Lo-D --> Lo-C/Hi-D	1073

The nomenclature here is perspicuous; for example the first entry indicates that a highly central and highly distinctive action was presented in the first position followed (after 1.5 seconds) by a highly central but non-distinctive action, and the mean reaction time was 873 msec.

If we are right that distinctive actions access their script, then conditions where a distinctive action (Lo-C/Hi-D or Hi-C/Hi-D) is presented first should facilitate the response. This is because the script should be accessed in the 1.5 seconds before the second action is presented. Having the appropriate context should speed the interpretation and processing of the second action, as well as simplify the sameness decision. When the first action is not distinctive (Hi-C/Lo-D or Lo-C/Lo-D), then the script is not accessed and subjects must try to access a contextualizing structure when the second action is presented. This prediction is equivalent to a comparison of the first six and the last six means above. The first six contained a distinctive action in the first position (_ _ _/Hi-D). The prediction was confirmed. The difference between the two sets of means was significant [$min\ F'(1,35) = 7.31$, $p < .02$]. The context accessed by a distinctive first action does help subjects to confirm that the second action is in the same script.

Our second prediction involves the centrality of the second actions following distinctive first actions. Central actions are the main goals and components of the activity. This prominence should be represented in the organization of the underlying knowledge structure. When the script is accessed by a distinctive first action, central second actions should be confirmed more quickly as components of that script compared with less central second actions. This prediction is tested by a comparison of the first three and second three means in the list above (_ _ _/Hi-D --> Hi-C/_ _ _ vs. _ _ _/Hi-D --> Lo-C/_ _ _). In this case the *Min F'* was not significant but the F for the subjects was 4.83 which was significant at the .04 level for one and 23 degrees of freedom [for materials, $F(1,21) = 2.03$, $p < .18$]. Thus the claim that central actions are more available than non-central actions when the script is accessed also received a certain amount of support.

It is possible to examine more fine-grained predictions for these data. Perhaps the purest test of our assumptions can be obtained by comparing conditions Lo-C/Hi-D --> Hi-C/Lo-D and Hi-C/Lo-D --> Lo-C/Hi-D. This compares the same actions in different presentation order. Clearly the preferred order is when the distinctive (non-central) action is presented before the central (non-distinctive) action. The first action accesses the script and since the centrality of the second action makes it more available for confirmation. The reversed order should be much more difficult since the script is not accessed by the first action and second action is not prominent in the script. There is a very large difference (160 msec) in favor of the optimal order of these two action types. The point is that the optimal order is facilitative because it exploits the functional organization of the knowledge structure.

The results of this experiment indicate the presence of two functional constraints on the organization of knowledge about common activities. Knowledge structures (like the scripts examined here) are used to provide context to better understand experience. This implies that the knowledge structures can be quickly accessed when the need for them becomes apparent. When an isolated action is encountered it is necessary to find a context into which it fits. The organization of knowledge structures must reflect this necessity. The distinctiveness of an action to a script can be represented as a link to the superordinate script concept. If a distinctive action is encountered, then this link can be traversed and the script concept retrieved. If the action is not distinctive then either the retrieval path is unavailable or too many available scripts are accessed and the context is ambiguous. Distinctive actions then provide one way to find an unambiguous context. Our results demonstrate that distinctiveness is a relevant structural characteristic in the functional organization of knowledge structures for common activities.

A second functional constraint is that knowledge structures must organize information in such a way as to have the necessary components available for utilization

by the comprehension processes. In other words, having a context means (among other things) being able to generate predictions about subsequent input in order to lessen the processing load when that input is encountered. This constraint would be satisfied if a list of all information that could possibly be relevant to the context were activated when the context was retrieved. Alternatively, since some of the information in a contextualizing knowledge structure is likely to be more relevant, it might be that this more relevant information is more available or more easily accessed. Such relevant information might include the main goals of the activity and the most important actions in the performance of those goals. If the comprehension system can keep only a limited amount of information about a context available for prediction, then this information is probably the best sort to have. For instance, if the restaurant context is involved in a narrative then it is a very good prediction that subsequent input will include something about the action of eating. Our results indicate that this more central information does benefit from a greater availability once the context is accessed. Here again we have demonstrated an important aspect of the functional organization of knowledge structures.

In conclusion, we take this research to be a beginning in the specification the functional organization of information in knowledge structures for common activities. Furthermore, we think our results outline a theory of getting and using context in order to understand experience.

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