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Contextual Effects on the Ability of Divers to use Decompression Tables

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SUMMARY

The present study compared the ability of novice divers to apply decompression tables having learnt how to use them in either the same or a different environment. Those subjects who had learnt how to use the tables in a different environment (i.e. had learnt on dry land and were tested underwater or vice-versa) performed on average 64 per cent worse than those who had the same environment for both learning and test. This effect could not be ascribed to the disruption brought about by changing environments. The results show that contextual effects on memory extend beyond the recall of word lists (Godden and Baddeley, 1975) to the ability to implement potentially important instructions.

One of the most dramatic examples of the effect of contextual change on recall has come from a study of divers (Godden and Baddeley, 1975). In this experiment subjects tried to learn lists of words either on dry land or underwater. They were subsequently asked to recall as many of the words as possible in either the same or the opposite environment. Those divers who had to recall the words in the original environment performed considerably better than those required to change environments, remembering approximately 50 per cent more words (Godden and Baddeley, 1975). The decrement associated with contextual change was found both for those subjects moving from wet to dry and those moving from dry to wet environments (Godden and Baddeley, 1975). In the light of subsequent failures to show reliable environmental effects on memory (Eich, 1980; Fernandez and Glenberg, 1985) it seems likely that the unusually large size of these contextual effects reflected the extreme changes in both external and internal environment experienced by the divers (Eich, 1985).

An important implication of the study by Godden and Baddeley (1975) is that practical problems may arise in those professions that require workers to recall information in changing contexts. Furthermore, the more extreme the shifts in context the more likely that such problems will occur. It must, however, be remembered that the marked context effect shown by Godden and Baddeley (1975) concerned the learning of random word lists, and so may not correspond to the type of memory demand typically made of divers. Anecdotal evidence that contextual changes can cause real practical problems comes from the apparent difficulty divers found in

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remembering fish behaviour that had been observed underwater (Baddeley, 1980). An even more serious problem could, however, arise if contextual shifts also impair the ability to remember important instructions that have been 'learnt' prior to a dive. This possibility was examined in the present study.

Although the study of Godden and Baddeley (1975) is widely cited as one of the clearest examples of contextual effects upon recall there were a number of shortcomings in the original study. For example, as the authors themselves admit, there was no control over time of day or the location of the dives. These factors become potentially important when it is realized that every diver was tested under every condition, i.e. each diver was given four different word-recall tasks. In addition, it was impossible in the original experiment to control for differential amounts of rehearsal among the four conditions and, as the authors say, 'the divers were in no way committed to the experiment' (Godden and Baddeley, 1975). An attempt was therefore made to exclude these shortcomings and so provide a clearer test of contextual effects on recall.

Thus, the present experiments had two related goals. The first was to examine the effects of context on the ability of divers to learn material, that, by its very nature is of practical importance. To achieve this, novice divers were tested on their use of decompression tables (a skill required by all divers) having been taught how to use them in either the same or a different environment. While this is not a direct test of recall it matches many naturalistic situations closely, i.e. where there is a need to remember and implement a set of complex instructions that have been given in a different context. The second goal was to avoid the shortcomings present in the original study on divers and recall (Godden and Baddeley, 1975). This was achieved by testing all subjects at the same time and place, and by carefully controlling activity during the retention period.

METHOD

Subjects

Subjects were 40 members (29 male and 11 female) of the Durham University Sub-Aqua Club. They were aged between 18 and 22. All of the divers were novices and had received the same amount of basic training.

Materials

All of the subjects wore standard SCUBA breathing apparatus and wore adjustable buoyancy lifejackets, masks, and fins. Testing took place at Durham City swimming baths.

Procedure

The 40 subjects were randomly divided into four groups of 10, with either two or three female subjects in each group. The four groups corresponded to four different conditions. These were: learn wet–recall wet (WW), learn wet–recall dry (WD), learn dry–recall dry (DD), learn dry–recall wet (DW). Each subject was tested only once, the entire experiment being carried out in the same session.

In the learning stage each subject was given a set of instructions on how to use decompression tables along with a standard set of tables drawn up by the British Sub-Aqua Club in 1988. For all subjects the two pages of instructions were printed on waterproof acetates, and tied to these were five further acetates with the decompression tables. The instructions explained why it is so important to modify the rate of ascent of a dive according to a number of factors, e.g. the depth and length of the dive and the interval since the previous dive. The instructions also explained how these various factors are to be applied to decompression tables if nitrogen narcosis is to be avoided, and a number of worked examples were provided.

Subjects were told to read the printed instructions as carefully as possible, as they would be required to show their understanding of the material later in the pool session. All subjects were given 10 minutes to read the instructions, during which the DD and DW groups sat by the edge of the pool with their masks tipped back and their regulators (breathing tubes) removed, while the WW and WD groups dived to the deep end of the pool where the heavy SCUBA equipment allowed them to sit on the bottom without difficulty.

The acetates were then collected and the subjects received 30 minute group instruction on expired air resuscitation. This involved all subjects putting on lifejackets and swimming in the pool. At the end of this period the subjects went to their alloted condition ('wet' or 'dry'), and were given acetates which contained question sheets and the sets of decompression tables. The subjects were given 5 minutes in which to write down the answers to nine questions which required the correct use of the decompression tables. All subjects, irrespective of whether they were 'wet' or 'dry', were given white plastic sheets on which to write the answers.

RESULTS

The mean number of correct responses for the four groups was as follows: DD = 6.3, DW = 3.3, WW = 5.0, WD = 3.9. From Figure 1 it can clearly be seen that those subjects required to use the instructions they had learnt in the same environment (WW or DD) performed better than those who had to remember them after a change of environment (DW or WD). This pattern of results was consistent with an analysis of variance which showed that there was a highly significant interaction ($F(1,36) = 19.13$, $p = 0.0002$) between learning and recall environment (Figure 1). The nature of this interaction was confirmed by a series of planned comparisons (all two-tailed) looking at changed/consistent environment (WW and DD vs. WD and DW), learning environment (WW and WD vs. DW and DD), and recall environment (WD and DD vs. WW and DW). As expected there was a highly significant effect of changing environment ($t(38) = 4.23$, $p < 0.001$). There was, however, no clear effect of learning environment ($t < 1$) or recall environment ($t(38) = 1.67$). Finally, there was no evidence of a difference between the scores of the male and female subjects.

DISCUSSION

The present findings helped to confirm previous evidence that the shift from above to below water (or vice-versa) is particularly powerful in exerting a context effect

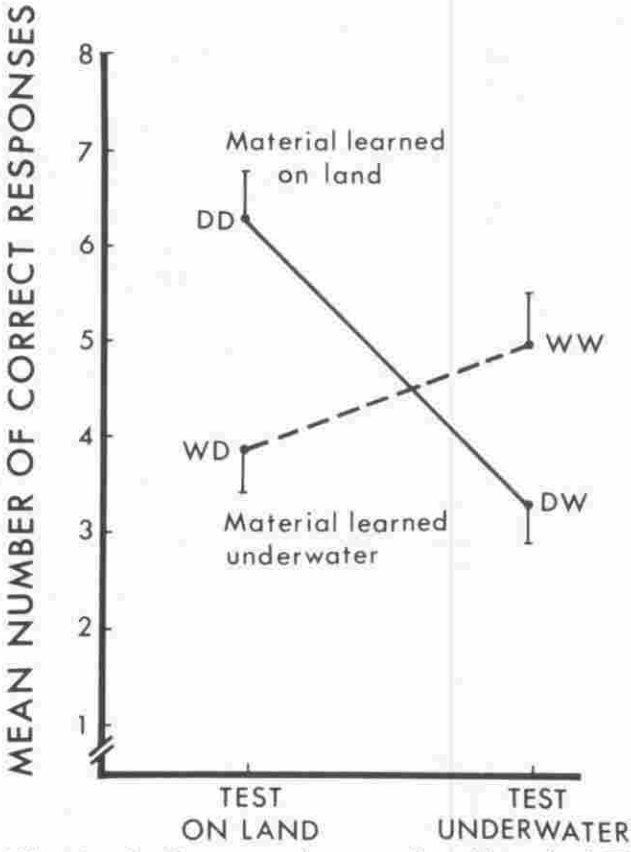

Figure 1. The ability of novice divers to use decompression tables on land (D) or underwater (W) having previously learnt to use them in either the same (DD, WW) or the different (DW, WD) environment. The vertical bars shown standard errors

on recall (Godden and Baddeley, 1975). It is most likely that the effectiveness of this manipulation stems from the dramatic changes in both external context and internal context ('state dependency'). Taken overall, it was found that those subjects who had to carry out the tasks in a changed environment performed at only 64 per cent accuracy of those who were in the same environment. This effect could not be ascribed to the changed environment subjects (DW, WD) suffering more disruption during the retention interval (Strand, 1970) as all subjects were taught resuscitation techniques during this period. Thus not only did all subjects perform the same tasks during the interval, but the training required them to put on lifejackets and swim in the pool, so involving both the 'dry' and the 'wet' environments.

The high significant interaction between place of learning and place of recall demonstrated that the divers were far worse at implementing decompression instructions following a change in environment. Furthermore, the clear crossover in the scores (Figure 1) shows that this effect worked in both directions, and that it was not an artifact of one condition being associated with either floor or ceiling effects. Additional comparisons showed that there was no effect of learning environment, and while there was some evidence that those subjects tested underwater (WW, DW) found the tasks more difficult, presumably because the subjects were novices who

were still unfamiliar with the environment and the equipment, this difference was not significant. These additional comparisons are important as they make it most unlikely that the interaction was a direct consequence of difficulties that the subjects had in either reading or comprehending the instructions while underwater, or subsequently performing the recall tasks underwater.

The present study, therefore, helps to show that the effects of context can extend beyond the recall of explicit lists of information to the remembrance and implementation of complex instructions. The potential importance of this finding is underlined by the fact that the material used is of enormous significance for all regular divers. Clearly it is bad practice to expect divers to be able to implement a set of complex instructions given on dry land unless they can demonstrate an ability to remember the instructions underwater. Furthermore, it is evident that the most effective training for divers will involve providing information in an environment as close as possible to that where the information will subsequently be required. A logical corollary of this is that the subsequent testing of such information should be given in the context where it is needed, and not where it might have originally been taught. This latter point is clearly borne out by present results.

While the present study only examined the effects of being above and below water, there is no reason to believe that similar results would not have been found for other major changes in external and internal context. As a consequence the impact of context upon training and testing might be expected to extend to groups of workers such as the armed forces, the police, and rescue services (Smith, 1988). It is also intriguing to wonder whether sportsmen and sportswomen suffer marked effects of context on the ability to remember information important to the game but learnt off the pitch.

Finally, it might be of practical value to determine whether merely thinking about the learning environment can attenuate the effects of changes in context as extreme as those encountered by divers. The work of Smith (1979) has shown that when subjects are asked to remember features of the room in which learning took place they perform better than control subjects. It might therefore be of practical benefit to encourage divers to think about being below water (or on dry land) in order to reduce the effects of contextual change on performance.

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