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Stress and Accidents

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Three types of stress are described: environmental stress, acute reactive stress, and domestic or life stress. Each of these is discussed and the evidence relating the stress to accidents is evaluated. This evidence is drawn from laboratory experiments, surveys, and accident and incident reports. It is concluded that there is good reason to link some forms of stress with accidents; possible ameliorative measures are suggested.

STRESS IS an intrinsic factor in many jobs. Many would consider being a coal miner or steeplejack to be more stressful, in one sense or another, than being a pilot. The special problem for the pilot, of course, is that subtle errors on his part can have large consequences. The purpose of this paper is to examine whether the sorts of stress to which a pilot may be exposed make the occurrence of such errors, and hence accidents, more likely.

Many theories of stress are based on the idea that all stresses (or stressors, as some would maintain—though this distinction is not maintained in this paper) affect human performance by influencing some common intermediate variable. Early theories proposed that this intermediate variable was "arousal" (16) and Selye (14) provides a different, though again global, description of the effects of stress in terms of his "general adaptation syndrome." However, from a practical point of view, in considering flying accidents, it is useful to discriminate between three kinds of stress: environmental, acute reactive, and life stress.

Environmental stress. For the military pilot this can mean noise, vibration, heat, cold, and even, possibly, mild hypoxia. The civil pilot is unlikely to be so affected by these problems (though the advent of large civil helicopters has introduced a somewhat less comfortable environment to the civil pilot than that to which he may be accustomed). He is, however, quite likely to be affected by sleep deprivation, whether he is a long haul pilot disturbed by transmeridian flight or whether he is flying, at night, on a local, solo, air taxi operation.

Acute reactive stress. The "fight or flight" syndrome of increased autonomic activity in the face of threat is well known and recognised and when confronted with an aircraft emergency a pilot is likely to experience such acute reactive stress. The questions of whether this condition is likely to generate error in skilled behaviour and whether the problem can be ameliorated are important ones.

Life stress. This is, possibly, the most intransigent area as it concerns the stress produced by recent life events, such as bereavement or divorce, or less obviously traumatic occurrences such as moving house or changing job. It is likely that the irregular life-style of the commercial pilot will subject him to a greater level of such stress than individuals in other occupations.

The first of these areas is massively researched and the experimental findings are well reviewed by Poulton (12) and Broadbent (4). This paper, however, is not concerned with theoretical models of the way in which environmental stress may affect performance, but with whether there is any evidence that such stress causes accidents. Within the Royal Air Force, flying accidents which involve human error are normally investigated with the assistance of a psychologist from the RAF Institute of Aviation Medicine (IAM), and to date about 70 accidents have been investigated in this way. It is interesting to note that of these accidents only three have involved environmental stress in their possible

aetiologies, and in two of these the stress involved was heat (one of the accidents occurring in Cyprus and the other in Belize). A possible reason for this low incidence is that the psychologists involved in investigating these accidents were simply not alert to the factor, but, given their background at IAM, this is not considered likely.

Examination of civil accident reports and incidents submitted to the U.K. Confidential Human Factors Incident Reporting Programme (CHIRP) substantiates the contention that environmental stress is not a potent factor in causing accidents and incidents. The reasons for this are probably several, the most important being that the civil cockpit—even in helicopters—does not present a severe enough environment to produce the changes in human performance and errors which cause accidents. Furthermore, in any experiment which considers the effects of mild environmental stress on performance the largest source of variance in the data is invariably the subjects (i.e., differences between individuals are almost always larger than the effects of the stress) and the magnitude of the stress effect is often minimal, if not actually spurious (9). From a practical point of view, it may thus legitimately be argued that as aircraft operating procedures must be established which are safe for the worst pilot who is ever likely to fly the aircraft, they will almost certainly accommodate any changes in performance which may be produced by a low level of environmental stress.

One possible exception to these considerations is sleep deprivation. Many reports in the CHIRP database refer to sleep and fatigue incidents, and the most dramatic of these incidents relate to those occasions on which the crew actually fell asleep (some of these being described in the CHIRP publication Feedback) (8). The easiest of these incidents to understand are those in which a single pilot was flying alone, at night, with little contact with air traffic control. However, other reports describe how the entire crew of a wide-bodied transatlantic aircraft fell asleep (only being awoken by an audio warning), and how the two man crew of a North Sea helicopter fell asleep during a morning flight. The flight safety implications of such events are obvious, yet after fatal accidents the notion that the crew was asleep is rarely, if ever, seriously entertained.

How safe, though, is the crew which is fatigued, and perhaps sleep deprived, yet not actually asleep? Many CHIRP reports are submitted by pilots who ascribe their error to fatigue, and there is some recent research carried out at the RAF IAM (not yet published) which suggests that sleep-deprived pilots required to fly a real aircraft on instruments commit more, and grosser, procedural errors than do fresh pilots.

It is, therefore, suggested that environmental stresses other than sleep deprivation and fatigue are not potent causes of accidents, but that the importance of disrupted sleep as a causative factor may actually be derestimated.

The second area is that of acute reactive stress. The conventional wisdom here is that a provocative event, such as an aircraft emergency, will increase the pilot's arousal level and that narrowed attention and disorganised behaviour are consequences of this. The experimental evidence in this area is weak as it is difficult, both practically and ethically, to frighten subjects. However, the work of Berkun (3), in which subjects were led to believe that they were in an aircraft that was likely to crash or, in another experiment, that they were accidentally being shelled with live ordnance, substantiates the common sense conclusion that such situations do indeed produce behavioural disruption.

Examination of RAF psychologists' reports also suggests that acute stress potentiates further error. For example, a Phantom (F4) aircraft was lost after suffering an alarming, but not necessarily disastrous engine failure during take-off. Though the pilot would almost certainly have coped with this situation in the simulator, he failed to manage the real emergency and the aircraft was lost. Similar anecdotes could be given about several other two-engined aircraft which have been totally lost after suffering failure of only one of the engines. Some aircraft have even been lost after a spurious warning (e.g., a Buccaneer after a spurious fire warning) or a relatively minor emergency (e.g., a Hawk lost after a brief and benign appearance of noxious fumes). It is not possible to be confident that all of these aircraft were lost because of the pilot's affective response rather than, for example, an increased level of workload resulting from the original emergency. Nevertheless, the pattern of response is sufficiently common to provide reasonable evidence that many pilots lose control of their aircraft as a fairly direct result of an increase in arousal or reactive stress.

In contrast to such incidents, many pilots experience severe emergencies and cope with them entirely effectively. Some of these pilots describe their feelings as being exactly as they were in the simulator when practising such an emergency. This suggests that the function of the simulator is not only to train the pilot in the actions appropriate to dealing with an emergency, but also to habituate, or perhaps condition, his associated affective response. If so, this clearly represents an important aspect of simulator training which could possibly be made more effective by giving it greater consideration.

The third stress problem outlined above is that of "life change" or domestic stress. Of the 300 or so CHIRP reports, only 3 make any mention that the error reported might have been caused by some non-flying problem, and in only 1 of these did the reporter directly attribute his error to being so pre-occupied. This is part of his report:

> For at least two to three years before the incident there had been a steady deterioration in the state of my marriage to the extent that I would get up in the morning unnecessarily early to get out of the house before my wife and child woke up. On this particular morning this did not occur and I was subjected to a non-violent but angry argument which left me emotionally boiling, a state I remained in throughout my drive to the airport, through flight planning and indeed up to the incident itself.

This pilot goes on to describe how he collided, because of his inattention, with an obvious obstacle, and concludes thus:

> I realised afterwards that the total loss of concentration caused by the fact that my mind was entirely filled with the continuing emotional conflict of the argument with my wife. Later we separated and as soon as the separation took place I could almost

feel the mental tension and build up draining away from me and I felt marvellous about my flying again.

Had this pilot been killed, it is extremely unlikely that his error would have been attributed to his domestic circumstances, for accident investigators are naturally reluctant to enquire into and air such matters unless they are unable to avoid doing so. A practical reason for this reluctance is the impossibility of drawing a direct connection between the accident and the domestic situation. The regrettable result is that, as full notes and records are not kept of these matters for individual accidents, it is not possible to review large numbers of accident reports to assess the incidence and importance of the problem.

However, apart from the kind of anecdotal evidence given above, there are several reasons why the "life stressed" individual might be relatively accident prone. Firstly, those troubled by a serious domestic crisis would, it might be argued, regard the hazards and risks associated with a lower than normal level of care in their job as trivial in comparison with their other problems. Adams (1), in his work on the efficacy of seat belt legislation, has persuasively suggested that we all operate to the level of perceived risk which we regard as acceptable. If perception of the acceptability, or subjective importance of the risk changes, a concomitant change in accident rate would be predicted.

Secondly, it is a tenet of cognitive psychology that any individual has a limited amount of mental processing capacity (5,11). It is also held that frequently executed tasks become automated and require little central capacity beyond regular monitoring during their execution. A large number of the reports received by CHIRP describe errors in such automated behaviour, sometimes because inappropriate behaviours or motor programmes are engaged, and sometimes because the intended programme was engaged, but proceeded to an unintended point because, apparently, of insufficient central monitoring (13). It could be predicted that a life stressed individual will have his mental capacity partially devoted to his problems and life events and thus be more likely to commit such a "programming" or inattentional error.

It might be reasoned that those of a more neurotic (7) than normal personality would, compared with stable individuals, be more affected by (i.e., will devote more of their mental resources to) disruptive life events, and that they will have more accidents as a consequence (10). There are many studies of the personalities of those involved in road traffic accidents, and though there is a weak suggestion in this work that above average neuroticism is a factor in determining accident proneness (15), it is not nearly as powerful a factor as the other dominant personality dimension of extraversion (2,15).

It should, however, be possible to address the problem of the relationship between life stress and accidents from a more epidemiological point of view. Alkov has been the most active worker in this area, and in a recent publication (2) he demonstrates that aircrew who were found to be at fault in an aircraft accident were significantly (statistically) more likely than those involved "innocently" in accidents, to:

Have marital problems;
Show signs of immaturity and instability;
Have recently become engaged to be married;
Be making a major career decision;
Not be professional in approach to flying;
Be having difficulty in personal relationships;
Have recently had trouble with superiors or been disciplined;
Be unable quickly to assess potential difficulties;
Recently have had trouble with peers or others (2).

The problem with this and similar studies is that the data were collected retrospectively. Only after the accident were flight surgeons asked to gather information, for example from the pilot's flight commander, about whether he felt that the pilot in question had had a professional approach to his flying. The temptation consciously to exercise wisdom after the event must have been great, and the possibility for the reporter's attitudes and perceptions to be modified subtly and unconsciously, unavoidable. A large scale prospective study is clearly called for, but this does not yet appear to have been carried out.

From the above, it is difficult to draw conclusions which could lead to clear-cut ameliorative measures. It does not appear that environmental stresses other than fatigue and sleep deprivation are likely to have general significance in the aetiology of accidents, and the solution to the sleep loss problem involves more industrial than scientific considerations. However, acute reactive stress is almost certainly an important factor in many accidents, and it is suggested that the simulator could be extended in its use to habituate pilots to the affective associations of handling emergencies as well as being used (as at present) to practice procedures. The life stress problem is possibly the most important of all, though little other than anecdotal evidence exists at present to substantiate such a notion. It is probable, though, that as the assessment of life changes and their importance become clearer, a requirement for an airline or airforce better to know and understand its pilots will emerge.

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