A pilot test of the effect of mild-hypoxia on unrealistically optimistic risk judgements

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***Abstract**: Although hypoxia is believed to occur above altitudes of 10,000 ft, some have suggested that effects may occur at lower altitudes. This pilot study explored risk judgments under conditions of mild hypoxia (simulated altitude of 8,000 ft). Some evidence of an increased optimism was found at this level, suggesting the need for a larger scale study with more experimental power.*

Introduction

The accurate perception of risk plays a key role in health and safety as it is often a determinate of subsequent behaviour (Gilbey, Fifield, & Rogers, 2006). However, in numerous situations, people's perception of risk is not accurate as groups generally believe that they are less likely than average to experience negative events, and more likely than average to experience positive events than their peers (Weinstein, 1980, 1987). When such an effect occurs for a group, it suggests that the group may be making a biased risk judgement as it is unlikely that all members of a group would be at less risk than average. This phenomenon is known as perceived invulnerability (Breheny & Stephens, 2004) or unrealistic optimism (Weinstein, 1980). Unrealistic optimism has been found to predict a wide range of behaviours that may make negative events more likely; for example, the more that people believe they will not catch a sexually transmitted disease the more likely they are to engage in unsafe sex, or the more people believe their driving is safe the faster they are likely to drive.

Researchers seldom attempt to demonstrate unrealistic optimism for a particular individual (Weinstein, 1980) as it is usually "…impossible to demonstrate that an individual's optimistic expectations about the future are unrealistic" (p. 806). That is, it can rarely be known whether an individual is optimistic about the likelihood of a negative event occurring because they have optimistic personality traits, or because they actually do have better skills than their peers. However, for a group of people "it is relatively easy to test for an optimistic bias. If all people claim their chances of experiencing a negative event are less than average, then they are clearly making a systematic error, thus demonstrating unrealistic optimism." (Weinstein, 1980, p. 806).

In aviation, it has been found that pilots generally believe that their chances of an accident are below average, whilst their flying skills are above average (Wichman & Ball, 1983). Similar to findings in the area of health behaviour, higher unrealistic optimism scores were found to be associated with decisions to continue on a simulated flight into deteriorating weather conditions, rather than to turn back (O'Hare, 1990). This is believed to be one of the most common causes of fatal accidents in general aviation (NTSB, 1987). Overconfidence in personal ability has also been found to predict whether a pilot would divert or continue into deteriorating weather conditions (Goh & Weigmann, 2001). Wilson & Fallshore (2001) suggested that pilots who fly into

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deteriorating weather may be overly optimistic about avoiding a weather related accident and about successfully flying out of the bad weather. The term 'press-on-itis' is sometimes used in aviation to describe the motivation of pilots who continue with a flight when the safe option might be to turn back.

It is widely believed that the consumption of alcohol may increase a person's propensity to take risks (Lane, 2004). For example, Fromme, Katz, and D'Amico (1997) found evidence that the mechanism by which increased risk taking occurs is related to people's risk perception: "participants rated negative consequences as less likely when they were intoxicated than when sober" (p. 27). Thus, alcohol consumption may increase unrealistically optimistic judgements and the subsequent likelihood of unsafe behaviours.

Increasing altitude is associated with a fall in air pressure. Harding (1983) argued that the fall in atmospheric pressure and the consequent reduction in the partial pressure of oxygen pose the greatest single threat to anyone who flies. When humans experience an absence of an adequate supply of oxygen they experience 'hypoxia'. Indeed, "even modern aircraft still expose their passengers to some risks from lowered atmospheric pressure" (Harding, 1983, p1408). It has been observed that some behavioural symptoms of hypoxia are not dissimilar to those exhibited following the consumption of alcohol; for example, symptoms such as euphoria, headache, fatigue and dizziness (Barcroft, 1925; Martin, Bradley, Buick, Bradbury, & Elborn, 2007).

In principle, neither the effect of alcohol nor hypoxia *per se* should occur to pilots. First, because CAA (NZ) regulations state that a pilot should not fly whilst impaired by alcohol, and second, because pilots either fly at an altitude of less than 10,000 ft, in pressurised cabins or with supplemental oxygen, and are thus below the threshold for symptoms of hypoxia (Tune, 1964). However, at a flight level of, for example, 8000 ft the blood saturation of oxygen at sea-level may nevertheless reduce from >97% to <92% and it has been proposed that some effects may thus still occur due to mild-hypoxia (e.g., Denison, Ledwith, & Poulton, 1966).

Given the behavioural similarities of hypoxia and alcohol consumption, the current study sought to investigate the possibility that mild-hypoxia may lead to impaired risk judgements, similar to those evidenced after alcohol consumption, which could predict risk taking. Should such evidence be found, then this may offer an explanatory framework for the phenomenon of 'press-on-itis.'

The purpose of this pilot-study was therefore to investigate the effect of mild-hypoxia (i.e., that which might occur at a height of around 8000 ft above sea level) on risk evaluation. Specifically, it was predicted that judgements of risk made under conditions of mild-hypoxia may demonstrate higher degrees of unrealistic optimism than judgements made under control conditions.

Method

Participants

Participants were 15 males who were recruited from undergraduate and post-graduate students of a university campus. No demographic information was elicited, but all were screened first for any underlying health issues. A small financial reward was provided to compensate for their time.

Materials

As part of a larger project investigating the effect of mild-hypoxia on complex cognitive reasoning, a Hypoxicator (BIOMEDTECH Pty Ltd, Melbourne, Australia) was used to manipulate the fraction of inspired oxygen (FiO2) for the duration of the

experimental sessions. During the normoxia session, oxygen availability was similar to that available at sea-level (FiO2: ~21%), while during the hypoxia session the FiO2 was adjusted such that it was equivalent to the level of oxygen available 8000 ft above sea-level (FiO2: ~14%). Consequently, participants' arterial blood oxygen saturation was reduced from >97% in the normoxic condition to below 92% in the hypoxic condition.

A short tool to measure unrealistic optimism about negative and positive events was developed for the purpose of this study. The experimental task required participants to rate the likelihood of a series of 16 future life-events, of which 8 were positive and 8 were negative. The 16 items were based on those used in earlier research (e.g., Weinstein, 1980; Gilbey et al., 2006). Participants rated each future life event for the likelihood that it would happen to them, compared to people 'like them'. For example, item 1 (negative) was, "Compared to other people like me, my chances of developing a drinking problem in the future are": Much above average, Above average, A little above average, Average for people like me, A little below average, Below average, Much below average (select one response option).

To analyse participants' risk judgements, the seven possible responses to each item were assigned numerical values ranging from 1 to 7, respectively. The degree to which the mean group score for any item varied from the numerical rating assigned to the response 'average for people like me' (value = 4) would indicate the degree of unrealistic optimism (or pessimism) for the group as a whole. Thus, for the positive items, unrealistic optimism would be demonstrated by a significant negative deviation from zero, and for the negative items unrealistic optimism would be demonstrated by a significant positive deviation from the value of 4. To facilitate the comparison of positive and negative scales, the numerical values assigned to the negative items were reverse scored so that, the same as for the positive items, higher scores would indicate unrealistic optimism. Whilst, of course, it cannot be known for certain if any individual is exhibiting unrealistic optimism, if the mean score of the group differs significantly from a value of 4, then this would be evidence of a group bias in risk judgements as logically the mean risk of a group should be 4. The 16 items that participants were asked to judge are shown in Table 1

Table 1. *The 16 items participants judged for personal risk*

Item	Negative	Item	Positive
1	developing a drinking problem	2	liking my job
3	attempting suicide	4	maintaining good relationships with my relatives
5	a heart attack before age of 40	6	having a successful career
7	becoming sterile	8	falling or staying in love
9	contracting cancer	10	living beyond 80 years of age
11	being fired from a job	12	travelling extensively
13	being the victim of theft	14	getting a wonderful surprise on my next birthday
15	getting infected with AIDS	16	staying healthy and fit to an old age

Design

The design of this experiment was within-subjects; all participants completed the 16 item measure in both mild-hypoxic and normoxia. The order in which they completed conditions was randomised.

Procedure

Participants completed three experimental sessions. The first session was to gain familiarity with the equipment (e.g., with wearing a face mask for up to two hours). In sessions 2 and 3, participants were randomly assigned to either normoxic or mild-hypoxic conditions during which they completed a series of complex cognitive reasoning tasks. At the end of sessions 2 and 3, participants also completed the risk perception questionnaire.

This study was subject to a full ethics application, which was approved by Massey University Ethics committee: Southern A, and is available for inspection upon request (application 09/74).

Results

Participants' responses were first examined for evidence of optimism in both experimental and control conditions. In both conditions, single sample *t*-test found no evidence of optimistic (or pessimistic) bias in responses for items 9, 10, 13, and 14; however, for each of the remaining items there was significant or strongly significant evidence of unrealistic optimism (range $p < .05$ to $p < .001$). The five non-significant items were excluded from further analysis, as the aim of the current study was to examine whether conditions of mild-hypoxia affected judgments of risk that were either unrealistically optimistic or had become unrealistically optimistic. This left 11 items in the main analysis

A measure of internal consistency, Chronbach's Alpha, indicated internal consistency of .722 for the 11-item scale when used under normoxic conditions (control condition) and .713 when tested under conditions of mild-hypoxia (experimental condition), thus suggesting that all 11 items could be meaningfully combined to measure overall risk judgements. Paired sample *t*-test showed no evidence of a difference between the overall scale means of the control (M_{cont} = 5.46, *SD* .56) and hypoxic conditions (M_{hyp} = 5.43, *SD* = .63), $t = .54$, $df = 14$, $p = .60$).

Table 2. *Mean, SD, and T-test results for individual items.*

Item number	Control condition		Hypoxic condition		Paired sample *t*-test (*df* = 14)	
	M	*SD*	*M*	*SD*	*t*	*sig*
1	5.80	1.21	5.53	1.25	2.26	.041**
2	5.20	1.21	5.13	1.41	.27	.792
3	6.47	.74	6.40	.91	.44	.670
4	5.40	.91	5.80	.86	-2.10	.054*
5	5.27	1.44	5.20	1.32	.22	.827
6	5.33	1.10	5.40	1.18	-.29	.774
7	5.00	1.31	4.67	1.23	1.44	.173
8	5.73	.96	5.40	1.06	1.78	.096*
11	4.87	1.13	5.27	1.10	-2.10	.054*
12	5.20	1.08	5.27	1.28	-.44	.670
15	5.67	1.23	5.73	1.33	-.44	.670
16	5.27	1.22	5.67	.98	-1.87	.082*

** = significant at p < .05, * = approaching significance

Paired sample *t*-tests conducted on each of the 11 individual items where there was evidence of unrealistic optimism, found evidence of a significant difference for item 1; however, this was in the opposite direction to that expected as there was evidence of decreased levels of optimism in the hypoxic condition compared to the control

condition, $t = 2.26$, $df = 14$, $p < .05$ ($M_{cont} = 5.80$, $SD = 1.21$; $M_{hyp} = 5.53$, $SD = 1.26$). Whilst not achieving statistical significance at $\alpha = .05$, it was noted that items 4, 11, and 16, and to a lesser degree, item 8, did approach significance ($p < .1$); moreover, the trend of differences were in the predicted direction for the items closest to achieving statistical significance, 4, 11, and 16. The mean scores and paired sample *t*-test statistics for the items tested are shown in Table 2

Discussion

Overall, there was no evidence of a significant effect attributable to mild-hypoxia for the mean of the 12 items that were judged optimistically. However, when compared individually, there was evidence of a significant difference for item 1, although it is suggested that mild-hypoxia may actually suppress unrealistically optimistic judgements. Contrarily, four of individual item comparisons did approach significance, of which the three closest to achieving statistical significance were in the direction that suggested mild-hypoxia could cause increased levels of unrealistic optimism.

Although there were no statistically significant findings in direct support of the possibility that conditions of mild-hypoxia may lead to increasingly unrealistic judgements of risk toward every-day life events, a series of unplanned comparisons regarding items 4, 11, and 16 provided some grounds to investigate further the possibility that mild-hypoxia may affect risk. One limitation of the current study was that it lacked experimental power; specifically, it may have been unrealistically optimistic to expect a sample size of 15 to detect what may have been a small and subtle effect. Moreover, the use of the same measure in both normoxic and mild-hypoxic conditions may have led to order-effects; for example, the participants simply remembered how they had responded before. Furthermore, whilst the tool developed for this study did detect unrealistic optimism *per se*, it may have been too blunt to detect small differences attributable to the experimental manipulation.

Although the study reported here was a small scale pilot study which aimed to test the effect of mild-hypoxia on risk evaluation, it nevertheless suggests there are grounds to pursue this strand of investigation further.

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