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THE DEVELOPMENT OF A BEHAVIOURAL RATING TOOL FOR USE IN PASSENGER EVACUATION RESEARCH

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THE DEVELOPMENT OF A BEHAVIOURAL RATING TOOL FOR USE IN PASSENGER EVACUATION RESEARCH

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Summary

Under the memorandum of co-operation ATA/CA-41 between the FAA and CAA, Cranfield University were asked to develop a passenger behavioural rating tool for the evaluation of passenger behaviour during evacuation tests.

In this report a system for the classification of the range and types of behaviour which may be observed during the evacuation of an aircraft cabin, is described. Based on this classificatory system a behavioural rating tool was developed which enables a comparison to be made between the performance of participants across a wide range of evacuation tests. It is hoped that the behavioural rating tool will also be applied to behaviour in accidents (where this information is available) and will provide a source of data which will be used to support the validation of mathematical models of cabin evacuations.

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1 INTRODUCTION

Aircraft evacuation research has been conducted by the aircraft manufacturers, regulatory authorities, Cranfield University and the Civil Aeromedical Institute (CAMI) in the USA since the 1960s. A number of accidents which occurred in the 1980s led the regulatory authorities of the United States and the United Kingdom to initiate new extensive programmes of research. Prior to this time, much of the research conducted by airframe manufacturers and the resultant data had been kept confidential.

The research carried out at Cranfield University (Cranfield) in the UK and the Civil Aeromedical Institute (CAMI) in the USA has varied in methodology and fidelity of simulation. In order to evaluate the effect these differences may have on participant behaviour and evacuation rates the CAA on behalf of the FAA commissioned Cranfield University to initiate a research programme.

In this report the development of a tool to be used for the analysis of human behaviour in emergency evacuations, which will allow the types of behaviours exhibited by participants to be categorised, is described. A review of the existing practices and methodologies used during evacuation experiments is included in Appendix A.

2 BEHAVIOURAL EVALUATION TOOL

2.1 Introduction

Following the review of existing cabin safety research methodology, it became apparent that there was a need to develop an analytical tool which would allow the types of behaviours exhibited by participants to be categorised. The use of such a categorical tool would allow the Aviation Authorities to attain a system for evaluating participant behaviour in any evacuation testing conducted, including certification tests. The aims of the tool development were to allow the assessment of different test methodologies and investigate the influence of particular passenger behaviours on the success of emergency evacuations. The latter aim was deemed to be of particular importance for the continuing development of computer evacuation models. The evaluation tool also had to be developed so that it could be used by an intelligent lay person who did not have extensive experience of evacuation testing.

2.2 Methodology

The design of the behavioural evaluation tool followed an iterative design process. The final evaluation tool design evolved from three complete iterations of design and testing. The evaluation tool was revised using additional raters until an acceptable consistency between raters was achieved.

Prior to testing each of the designs of the tool, raters were given training in how to use it, in-depth descriptions of each of the behaviours and examples on videos of each of the behaviours. They were also given an opportunity to practice using the tool prior to data collection.

2.2.1 *Design one*

The initial formulation of 'behaviour types' to be included in the rating scale were developed through discussion with specialists within the field of cabin evacuation research and regulation. Researchers also observed a range of video recordings from Cranfield and CAMI's evacuation research as well as evacuation demonstrations in order to gain a broad overview of the many and varied behaviours exhibited by participants.

The initial evaluation tool design (Appendix J) included the key behaviours developed in the initial consultative stage. In order to assess the contribution of each item, three independent raters used the tool to evaluate passenger behaviour from a range of evacuation methodologies.

It was initially hoped that raters would view all of the relevant video clips simultaneously on multiple televisions. However, during pilot rating sessions the raters reported that they were unable to extract the relevant information from all of the tapes when they were shown simultaneously. In order to overcome this difficulty raters were asked to rate passenger behaviour from one camera view at a time. Two camera views were utilised, the first showed the whole of the cabin interior allowing the rating of all of the passengers whilst egressing through the cabin. The second view showed either the bulkhead or type III exit (depending on the type of evacuation test that was being carried out), this allowed an evaluation of behaviour at possible choke points as well as egress away from the aircraft, either by platform, wing or slide.

At the start of the evacuation the timer on the video player was set at zero seconds. The tapes were then played for 5 seconds and paused. The rater was then asked to indicate, for each of the items on the evaluation tool their assessment of the percentage of participants indulging in the behaviours and the overall intensity of the behaviours. The video tapes were then restarted and after a further five seconds stopped. The rater was again asked to indicate their assessment of the behaviours for all of the items on the evaluation tool as well as their intensity. This process was continued every five seconds until the evacuation was completed.

It was hoped that from these data, for each evacuation, a score would be calculated. However during piloting the raters reported that they found it impossible to accurately 'count' the numbers of passengers performing each behaviour and at each intensity. They also indicated that they were unable to distinguish between many of the behaviours and suggested compacting many of the separate conditions into one. As a result of this first pilot trial it was decided that a more holistic approach was required.

2.2.2 *Design two*

The same procedure was utilised to test the second iteration of the design, shown in Appendix K. This design amalgamated many of the similar behaviours into a single category, the raters reported that this had eased the difficulties they had had in trying to distinguish between similar behaviours.

The way in which raters rated the behaviour also changed. The raters were now asked to look at five second segments and provide a rating for the 'over-all or average' intensity of each behaviour type. The raters reported that this made rating

simpler and more accurate. This was also evident in the consistency among the raters.

However, the raters did report that the behavioural anchors which had been given to either ends of the five point scale were not sufficient to support accurate ratings. As a consequence of this a clear description for each of the points on the scale for each behaviour were devised.

2.2.3 *Design three*

The behavioural anchors and rating sheets for the evaluation tool are shown in Appendices L and M. Independent raters were shown two different camera views, the inside of the cabin and an outside view looking directly at the overwing exit and asked to rate the intensity of the 'over-all/average' passenger behaviour.

At the start of the evacuation the timer on the video player was set at zero seconds. The tape was then played for 5 seconds and paused. The rater was then asked to indicate, for the first particular behavioural type their assessment of the overall intensity of the behaviour. The video tape was then restarted and after a further five seconds stopped. The rater was again asked to indicate their assessment of the behaviour for that particular item on the evaluation tool. This process was continued every five seconds until the evacuation was completed. The rater was then asked to begin the whole process again until they had made a rating for all of the behaviour types.

In order to evaluate the final design three independent raters were shown videos from three different research methodologies. The research methodologies tested were a 50% motivational payment system, a co-operative bonus system and a delayed payment system (see Appendix A for details). The video clips utilised in this stage of evaluation of the research tool were randomly selected. All of the evacuations evaluated were through a Type III exit.

2.2.4 *Results from Design Three*

The raters were asked to rate each of the behaviour types in turn at five second intervals during the evacuation. The ratings for each of the raters are shown in Appendix N. In order that a consensus among the raters was found the three raters ratings were averaged. As Figures 1 and 2 show, the use of such an evaluation tool provides a graphical overview of how passengers' behaviour changed during an evacuation trial.

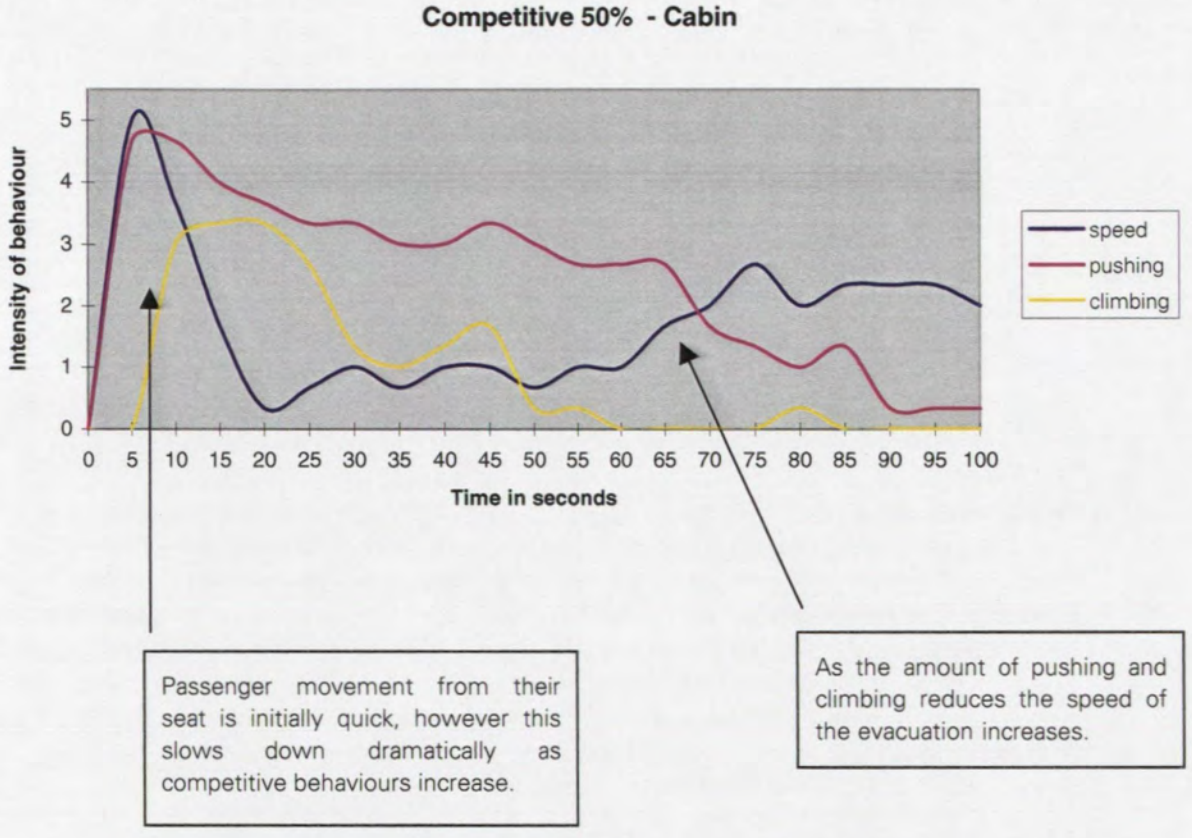

Figure 1 Average rating for passenger behaviour within the cabin - 50% competitive trials

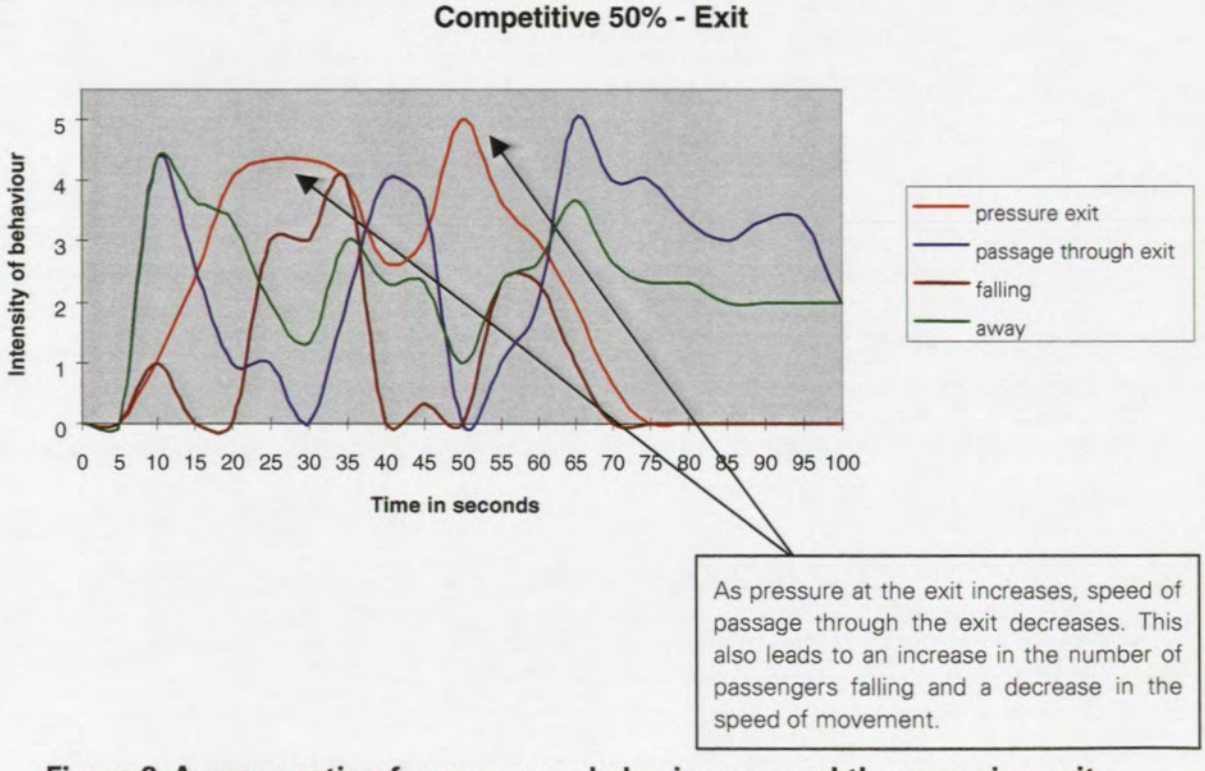

Figure 2 Average rating for passenger behaviour around the overwing exit – 50% competiive trials

The average behaviour ratings can also be used to compare the effect of changes to bonus payment systems on specific passenger behaviours. For example as Figures 3 and 4 show in the three different types of evacuations that were rated there was significantly more pushing and climbing in the two competitive trials than the co-operative trial.

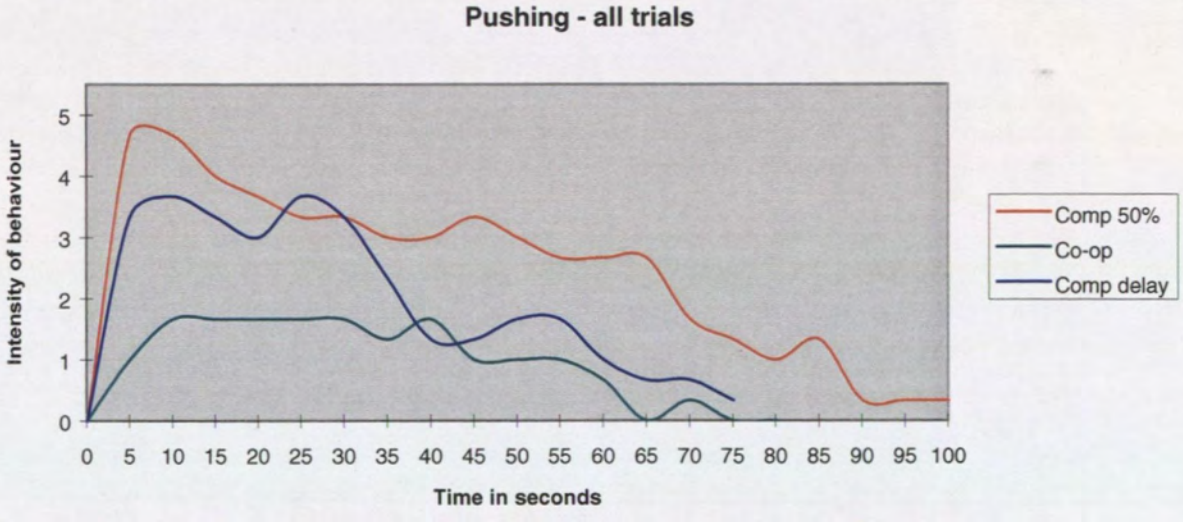

Figure 3 Amount of pushing within the cabin - all motivation types

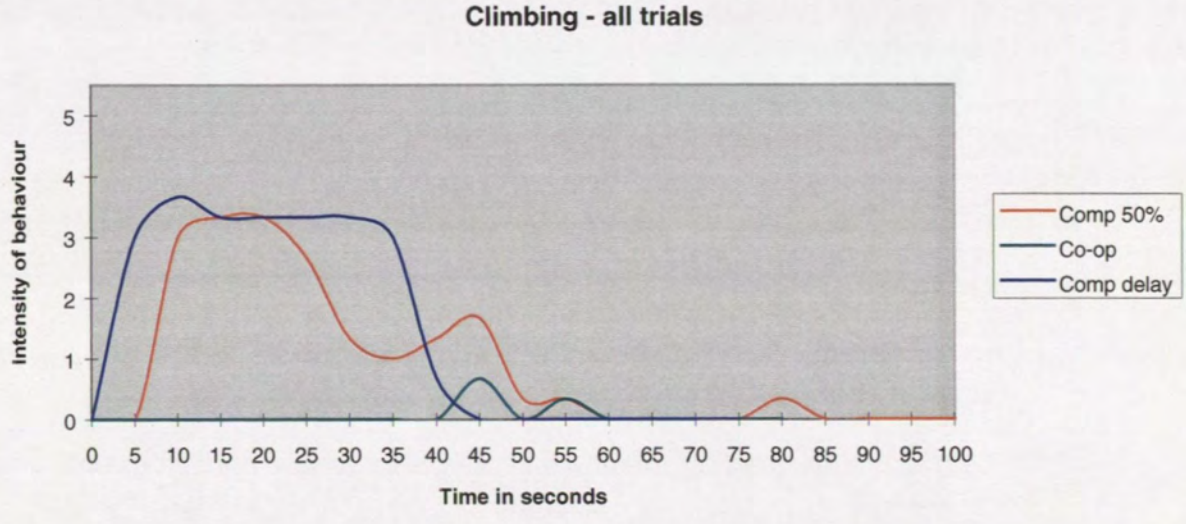

Figure 4 Amount of climbing within the cabin - all motivation types

3 DISCUSSION

The results indicated that the evaluation tool could be applied to data from the range of test methodologies which have been developed. The use of such an evaluation tool provides a means of illustrating how passenger behaviour changes during an evacuation test. The tool also provided a means to investigate the relationship between different passenger behaviours and the way in which they interact with each other.

The results clearly indicated that intelligent lay people could be trained to use the behavioural rating tool, even if they had never been involved in an evacuation testing programme. As the behaviour types were refined the raters found it relatively easy to distinguish between them.

During the course of the development of the behavioural rating tool it became apparent that retrospective analysis of the tapes was made difficult by the camera positions which had been used, both at CAMI and Cranfield. All of the independent raters reported that the greatest difficulty that they had in using the tool was that they were unable to see clearly all of the passengers at any given time and often had to remind themselves to rate only the behaviours they could see.

In future evacuation trials, camera positions and lighting need to be carefully considered to aid the use of the behavioural evaluation tool. Such improvements in the quality of the video footage would lead to further improvements in internal and inter-rater reliability.

4 CONCLUSIONS

1 A 'Behavioural Evaluation Tool' for passenger behaviour in the cabin has been produced.

2 The tool can be used to allow comparisons between facilities and methodologies to be systematically quantified.

3 The tool can also be used for the evaluation of the influence of group composition and numbers of participants on evacuation performance (e.g. age, personality, mobility).

4 The use of the tool has shown the requirement for changes to the camera lighting and camera positions used in future research.

5 The tool can be used by an intelligent lay person who has been given suitable training.

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Appendix A – Review

A summary of the experimental programs undertaken by CAMI and Cranfield, together with the experimental details can be seen in Appendix B.

A.1 RESEARCH FACILITIES

In order to conduct research into cabin safety and the factors influencing survival in aircraft accidents, facilities are required for experimental work. A range of simulators that represent parts of the aircraft cabin have been developed for this purpose. Video cameras are used for recording the behaviour of participants.

A.1.1 **Cabin Simulators**

The first facility to be developed for this purpose was built at CAMI in 1969. It was built to represent part of an interior of a narrow bodied fuselage. The simulator can be raised to provide any door sill height between ground level to 16 feet above the ground. The evacuation slides used are typical aircraft emergency evacuation slides. Netting and padding are used to prevent injuries to subjects falling off the slides during an experiment. Two research personnel are stationed at the end of the slide during use. These people are referred to as slide catchers. Their job is to assist subjects leaving the slide to minimise the risk of collisions between subjects. Slide catchers may immediately stop an experiment if they feel an unsafe situation is or has developed. The facility possesses a pair of floor level exits with dimensions that can be modified by the use of inserts to represent those of Type I exits. The facility also has a pair of Type III exits. The exits are from a Boeing 720 aircraft, and are installed in adjacent rows on one side of the cabin. The cabin must be on the ground to use the Type III exits. An addition the rear of the cabin contains staircases from multi-deck aircraft (one from a 747, the second from an L-1011) for use in experiments related to multi-deck evacuation. The interior of the cabin contains economy class triple seat assemblies on either side of the single aisle. Luggage lockers are installed above the seats at the appropriate height. The cabin can seat a maximum of 75 subjects.

Figure 1 The CAMI aircraft cabin simulator

Figure 2 The CAMI evacuation slides

Much of the recent work at CAMI has involved configuring the simulator to represent an aircraft similar to a Boeing 737, although the inside of the aircraft simulator does not confirm to the exact dimensions of any one aircraft. For most of the experimental work the bulkhead through which passengers must travel to reach the Type I exits is not present, although one may be fitted when necessary. The simulator does have Type I and Type III exits in-situ. In some of the recent work the exits were covered by fabric which was removed by experimental personnel at the start of the evacuation. The cabin simulator is located outside. The simulator has no windows (or simulated windows inside the cabin.). Cabin lighting can be set to the minimum emergency lighting level required by airworthiness regulations, or to a normal indoor lighting level. The CAMI simulator also has the facility to fill the cabin with a vision obscuring non-toxic theatrical smoke.

In 1986 experimental work began at Cranfield using a Trident fuselage parked on the airfield. The interior of the fuselage included all of the original cabin fittings, although floor proximity lighting and a smoke facility were added. The slide facilities were replaced by ramps located outside the exits on the port side of the fuselage. This facility was used for experimental work until 1996 when it had to be broken up and removed.

In 1990 an aircraft cabin simulator configured to represent a Boeing 737 was donated to Cranfield and is currently located in one of the hangers (see Appendix C for dimensions).

Figure 3 The Cranfield aircraft cabin simulator

All of the cabin dimensions in the simulator meet the current regulations, although bulkhead widths and galley dimensions can be altered. The simulator has two Type I exits at the front of the cabin and a single Type III exit in the centre of the aircraft. All of these exits can be operated during the trials. The configuration of the simulator allows the study of paired exits and exit selection, and although the

simulator currently only seats sixty participants (roughly half the capacity of a Boeing 737) by turning the seats around, evacuations from exits at the rear or front of the cabin can be simulated.

The simulator has two evacuation slides attached to each of the Type I exits. The sill height is 10 feet. The slides are specially constructed aircraft emergency slides which have had sides incorporated to remove the risk of participants falling off. Netting has also been placed around the slides to catch participants in the unlikely event that they did fall off. Two airfield firemen are stationed at the bottom of each of the evacuation slides to help participants off the slide quickly in order to reduce the likelihood of collision injuries.

Figure 4 Cranfield evacuation slides

As the cabin simulator is located in a hanger at Cranfield, it has the advantage that interior and exterior lighting levels can be controlled by a computerised system. Lighting levels can range from certification demonstration lighting levels through to bright daytime levels. There are simulated windows inside the cabin which are lit by fluorescent lighting behind the aircraft skin. These do not allow external light into the cabin. The cabin lighting levels are varied from the interior experiment control station. The cabin has typical emergency lighting and the ability to introduce theatrical smoke into the cabin within seconds.

During evacuation trials repairs have to be made to the aircraft seats and lockers. The type of repairs most frequently made are broken arms on the seats due to passengers climbing on them. Generally, such breakages occur once or twice during a test day. The other type of repair made is to broken seat backs. Seats generally break around the reclining mechanism, and such breakage usually occurs during particularly aggressive tests. It should be noted that the seats used during testing are decommissioned aircraft seats. The older seats used in evacuation tests require more attention.

Cranfield has also conducted tests using a 707 fuselage located in a hanger at The Fire Research Test Site at Cardington (12 miles from Cranfield). The fuselage had previously been used for fire testing and an evaluation of the influence of cabin water spray systems. Part of the interior of the fuselage was refitted with basic seating and cabin fittings (no upholstery) in order to evaluate the influence of cabin water mist on evacuation behaviour. Ramps were used in place of slides at this facility.

CAMI has recently acquired a retired Boeing 747 aircraft, which is presently being configured for use as a wide bodied evacuation research facility.

Both CAMI and Cranfield have requirements for additional facilities, which will enable them to provide the data that will be required by the Safety Regulatory Authorities in the future. This is particularly important with the emergence of novel design concepts such as the VLCT and blended wing. Cranfield has recently been awarded a contract to build a modular wide-bodied simulator. The program has been completed with the building of a wide-bodied double decker cabin simulator.

A.1.2 **Subject Population**

Large numbers of participants may be required for many of the experiments. An organised procedure is therefore required for this purpose.

CAMI uses a local company to recruit their volunteers. The use of the recruitment company is beneficial for two reasons. Volunteers are employees of the contractor, and as a result of this relationship, the contractor (who is paid by CAMI) is responsible for recruiting, screening, and paying their employees. Secondly, in the event of a subject being injured during a test, the contractor, through their worker's compensation insurance, is responsible for medical care. CAMI provides the recruitment company with a volunteer specification, which includes the required number of subjects for each session, distribution of males and females, height and weight restrictions, and age restrictions. Generally there is a limitation that subjects have no mobility impairments, and that they have never participated in an evacuation, or an evacuation test. It is also possible to specify the education and/or occupation if that is part of the experimental design. The specifications for the volunteer population vary from test to test in order to involve specific populations that are of interest to the research question at hand. Unlike Cranfield, the maximum age of participants recruited is as a function of the experimental design. An example of an experimental study carried out by CAMI using specific volunteers who might ordinarily not be included in other evacuation work was the research investigating emergency evacuation of handicapped air travellers (Blethrow et al 1977).

At CAMI, testing is carried out during the week, either in the morning or afternoon. Studies have been conducted in the evening, when lighting was an experimental issue being studied. Tests carried out during weekdays, involve unemployed participants although most of the subjects are either employed, or students. On occasions non-attendance of volunteers has been a problem.

CAMI participants are not given any specific information about the tests prior to attendance on the test day apart from being informed that they will be involved in a simulated evacuation study.

At Cranfield, a member of the research team is in charge of recruiting all of the participants. This is done by advertising locally using posters and newspaper advertisements (see Appendix D). On volunteering, participants are sent further information about the demands of the experiment and a detailed list of medical conditions and age restrictions that would preclude their participation (see Appendix D). All of the volunteers must be physically fit and aged between 20 and 50 years old. These age limits are set as a result of the insurance cover for the participants. The information they receive also clearly explains the payment systems in use during those particular trials. Participants are asked to return a form indicating their preferred evacuation test date. The evacuations take place either in the evening or on a Saturday morning, allowing for a mixture of participants from a variety of backgrounds and professions. Participants are asked to record their age and sex on the form, which allows the researcher to select participants meeting the required distributions. On each test day at least a third of participants are female. As at CAMI, non-attendance can be a problem. In order to allow for volunteers who do not turn up or who drop out after the participant briefing session, an extra six participants are recruited for each test day.

A.1.3 **Data Collection**

A.1.3.1 *Video Recording*

Video cameras are used for recording behavioural data at both CAMI and Cranfield. The number, positioning and type of cameras used is determined by the nature of the data required.

At CAMI the evacuation trials are recorded on video cameras with timing capabilities. Camera placement varies depending on the variables being tested. Recent evacuation work through the Type III exits used two cameras placed inside the aircraft cabin and two outside focused on the exit. During evacuations with low level lighting, as the simulator is outside, flaring of light has made some of the video data difficult to interpret. Flaring was also a problem on some of the Trident experiments through the overwing exit at Cranfield, although the problem was not so dramatic as lighting levels in the cabin were normal/bright. During evacuation in smoke, infra-red cameras may be used if there is a need to record images in the smoke. Infra-red camera output is an NTSC signal recorded on a standard VCR.

At Cranfield the behaviour of participants during evacuation trials is recorded using video equipment with timing facilities. At least five camera placements are used for filming the evacuations, although these can change according to the testing variables. Recent experiments have placed cameras in the following positions. Two cameras with low level lighting/darkness capabilities are placed outside focusing on the exits and slides. An additional camera is placed outside looking through what would be the cockpit door into the cabin. A further two low level lighting cameras are used inside the cabin. One is placed looking from the control station into the cabin. The second, placed in the middle of the cabin focused on the bulkhead, can be moved around to allow the filming of behaviour relevant to the particular variable being tested, for example exit operation behaviour. The cameras are very small and attached to the overhead lockers and to date have not been disturbed by participants evacuating. During some recent work two 'fish-eye' cameras were used to film cabin crew and passenger behaviour in the vestibule area. Infra-red cameras are used for safety purposes when carrying out evacuations in smoke however video data cannot be recorded from them.

Both CAMI and Cranfield have experienced difficulties in collecting video footage from experiments carried out using a simulator in outside locations. This is a particular problem when conducting trials through Type III exits when the brightness level coming through the exit aperture is much greater than the interior illumination level, causing flaring. Cranfield's B-737 simulator located in the hanger enables these problems to be overcome. An additional problem that can occur during evacuation studies of this nature is that the closest subject to the camera can eliminate views of the rest of the cabin (particularly if they are climbing across seats). The introduction of some type of a tracking system would be beneficial in order to determine the location of each subject in the cabin as a function of time.

A.1.3.2 *Video data*

At both CAMI and Cranfield, passenger flow rates through the exits are obtained from the video recordings. The cameras internal time base and audio recordings provide information on the time taken for each individual to evacuate and the order in which they disembark.

At CAMI evacuation times are calculated from the point at which the buzzer sounds to start the evacuation. Calculations of total evacuation time and mean individual evacuation times omit the last one or two subjects from analysis to allow for change in behaviour related to their rearmost positions in the queue. Passenger flow rates through the exits are obtained from the video recordings.

At Cranfield an individual's time to evacuate the aircraft is calculated from the command "Undo your seat belt, and get out" to when they reach the bottom of the evacuation slides/step out onto the wing. An attempt has been made to measure individual's response time to the evacuation command, however, this was unsuccessful as passengers seemed to react almost immediately in the test situation. The evacuation rates (the time for each passenger to evacuate) are calculated using the time for the last passenger who received a bonus payment to reach the ground. Since bonus payments were only available to the first 75% (or 50% depending on the programme) of passengers, and there are approximately 60 passengers on the aircraft, it is assumed that some of the passengers coming out after this point may not be competing. For this reason, their data is not included in the analysis.

A.1.3.3 *Questionnaire Data*

At CAMI personality data (NEO Personality Inventory™, Jackson Personality Inventory) and measures of coping style in stressful situations (Coping Inventory for Stressful Situations©) are collected from all of the participants. Additional information is not collected after each of the evacuation tests.

At Cranfield the experimental data is complemented with questionnaire data from participants (see Appendix E). After each evacuation, participants fill in a questionnaire in which they are asked about their experiences. The questionnaire also contains specific questions related to the variables being tested. This information has provided a useful insight into the experiences of participants during the tests. In addition to the evacuation questionnaires, the 16 Personality Factor questionnaire has been used during various test programmes. Data has also been collected using a personality test currently under development by Dr N. Latman under Transport Canada sponsorship.

A.1.4 **Experimental Design**

The design of individual experimental programs is a function of the information required. This includes consideration of the degree of realism required, and the amount of information given to participants prior to taking part in a test.

During most of their experiments, CAMI has employed a design using independent groups of participants taking part in five evacuations (although the number of tests varies as a result of the experimental question). The test order is counterbalanced and seating location for the subjects is random across all of the trials.

At Cranfield independent groups of participants take part in four evacuations. In general, experimental design is limited to four evacuations per test day as previous studies have shown that after this point participants begin to tire and the chances of injury may increase. Test order is counterbalanced to allow for learning effects. Participants are given a different seat during each evacuation so that they have an equal chance of receiving bonuses across the four evacuations

A.1.4.1 *Bonus payments*

In an attempt to reproduce the rush for the exits that can occur in an accident when passengers perceive an immediate life threat, both Cranfield and CAMI have used a competitive motivational protocol with a range of financial bonus systems

At CAMI, participants are paid $12.50 per hour for their participation in the trials, with a minimum of 2 hours guaranteed. In addition to this, "High motivation" groups are told that an additional $50.00 will be paid to the first 25% of participants out averaged over the tests run that day. This payment along with their attendance fee is paid by their employer, the contractor, some weeks after participation in the test.

As well as an attendance payment of £10, Cranfield employs two bonus payment types - competitive and co-operative tests. The competitive tests involve offering an additional £5 to either the first 50% or 75% of participants out of the exits used. The co-operative evacuations offer £2.50 to all of the participants if they all get out within a certain time. Bonus payments are all made in cash immediately after each of the tests.

A.1.4.2 *Participant briefing and medical screening.*

At both CAMI and Cranfield, prior to taking part in any experimental tests all participants are briefed and given a medical examination.

At CAMI, on arrival, prospective participants are given a general explanation of the purpose of the study, detailed information about the procedures to be used and provided with (if relevant) visual information and briefings about how to use the escape slides. After having any relevant measurements taken (height, weight, personality inventories such as the Jackson Personality Inventory, or the NEO Personality Inventory™ & Coping Inventory for Stressful Situations©), participants are asked to read and sign (if they are prepared to take part) an 'informed consent' document. This contains pertinent safety information, a description of hazards associated with the tests, and a description of the test subject's responsibilities. After completing a medical questionnaire designed to identify subjects with medical

conditions that will disqualify them, they are examined by either a physician or a physician's assistant. The examination is used to make the final determination of the subject's medical fitness to participate. Participants are then given the opportunity to ask questions before having the bonus payment system (if being used) explained to them. Appendix F contains copies of all of the documents given to the volunteers prior to their participation in the tests.

On arrival at Cranfield participants are given information to read which outlines medical conditions that would prohibit their participation, insurance information and more detailed information about the evacuation trials. They are asked to read the information carefully before signing a consent form. Copies of all of the information given to volunteers prior to participation can be found in Appendix F. Once all of the participants have been given a brief medical examination and had the relevant experimental data collected (height, weight, shoulder width, 16 Personality Factor test etc.) the experimental team leader briefs the group. The briefing first provides participants with some background information about Cranfield, aircraft safety and the reasons why such testing is carried out. This is followed by the logistics of the trial, how the test day is organised, the number of tests, how the evacuations are run and the bonus payments. It also covers, in detail, all of the safety aspects of the evacuation trials, particularly how to use the evacuation slides and the emergency stop procedure. At this point it is made very clear to all of the participants that they can drop out at any point during the test day and still be paid for their attendance. After an opportunity to ask questions, participants are asked to remove all jewellery and put on their numbered vest indicating the seat that they are to sit in for the first test (Appendix G contains a transcript of a typical briefing).

A.1.4.3 *Protocol*

At CAMI, after their briefing, participants are escorted to the simulator where they are photographed wearing their subject number vest. They are then given a boarding pass, which indicates the seat number that they are to sit in for that particular trial (this is collected from them by a researcher before the start of the trial). Once everybody has boarded the simulator, a briefing is given (sometimes by video) which covers safety and task briefings, this includes guidance on how to fasten seat belts and the signals for starting and stopping a trial. The trials are started with a bell. If an emergency occurs during the trial, it is halted by one of the designated researchers with a 'kill switch' this sounds an alarm that immediately stops the test. On completion of the trials, subjects are debriefed and dismissed. Generally, exits are opened by research personnel involved in running the experiment.

The details of the protocol are largely determined by the research question. Typically at Cranfield, after the briefing, participants are escorted to the simulator where they are shown to their seats (the number on their vest) by the cabin crew members. Once all of the participants have boarded the aircraft, the cabin crew members present a typical pre-flight briefing before seating themselves in the jump seat at the front of the aircraft. Passengers then hear one of a variety of emergency scenario tapes before the command 'Undo your seat belts and get out' is given (see Appendix H for transcript). This is the cue for the participants to evacuate by whichever exits are opened by the crew members. Depending on the research question, if the Type III exit is to be used, either a researcher or the participant seated next to the Type III exit would operate it. Once the evacuation is completed passengers who received a bonus ticket outside the exit exchange it for a five

pound note. Participants are then asked to fill out a questionnaire that asks them about their experiences during that particular trial (see Appendix E). Once the simulator is ready participants are issued with a new numbered vest, indicating their new seat number and asked to board the simulator to start the procedure again. The seating is arranged so that all of the participants should have an equal chance, across the four tests, of receiving the bonuses.

On completion of the four trials, participants are debriefed, thanked for their time, and paid for their attendance. Participants are always invited back to a presentation of the results from the experiments in which they took part.

At both facilities, there is frequently a requirement for cabin crew to perform the emergency duties. Indeed, in some experiments, it is the cabin crews influence on passenger behaviour that is being assessed. At Cranfield the individuals used as members of cabin crew during the trials are all members of the research team who have trained in emergency evacuation techniques. By contrast, CAMI use professional cabin crew who are in current employment with an airline to perform this role in their experiments.

A.1.5 **Participant protection and Injuries.**

A.1.5.1 *Ethical protection for participants*

One of the difficulties associated with research involving human participants in potentially dangerous, frightening and stressful situations, is to ensure that they are adequately protected from physical and mental harm, and that they are not subjected to unnecessary risk of injury.

At CAMI, all research proposals and methodologies are reviewed by an Institutional Review Board (IRB). The committee is made up of five members of varying backgrounds. At least one of the members is not a US government employee. The IRB is governed by specific guidelines in the Code of Federal Regulations, Title 49, Volume 1, part 11 "Protection of Human Subjects." These regulations are based on the Model Federal Policy for the Protection of Human Research Subjects, adopted August 1991. The makeup of the CAMI IRB is a Chair (a CAMI employee), an FAA safety officer (FAA employee, but not a CAMI employee), a non-FAA employee with a bioethics background, and the Division Managers of the two research divisions within CAMI. The Manager for the division, proposing a project, excuses themselves from voting on that project. An attorney from the FAA's General Counsel's office has also served on the IRB.

Cranfield University has an Ethics Committee, which is required to review all experimental work involving human participants before it is conducted. The Ethics Committee is guided by the British Psychological Society Publication "Ethical Principles for Research with Human Subjects" published in 1978 and revised in 1996. Its primary function is to represent the general interest of volunteers who take part in experiments. For an experimental protocol to be approved it must have unanimous support of all of the members of the committee. The members of the committee are as follows:

Head of Human Factors Group, Cranfield University
One other academic staff member from the Human Factors Group

One academic member of staff from Cranfield University who is not a member of the Human Factors Group
A Medical Practitioner
A Lawyer
Two lay members (1 male, 1 female).

A.1.5.2 *Injuries*

Occasionally participants in the Cranfield tests have sustained minor cuts/bruises and sprains. Two participants have sustained injuries whilst using the evacuation slides. One lady fractured her anklebone due to incorrectly jumping on the slide. Another participant bruised their coccyx badly by striking the sill of the aircraft.

At Cranfield a total of 1,770 participants have used the slides constituting 7,080 jumps down the evacuation slides. One individual has reported that participation in the tests has made them apprehensive of flying. He has been provided with counselling to enable him to overcome his fear of flying. Although the list of medical illnesses in the pre-test questionnaire includes fears and phobias as a factor precluding participation in the trials, this individual chose to ignore this, believing that participation would help his fear of flying.

Occasionally cuts/bruises and sprains have also been sustained during the trials at CAMI. Participants have injured themselves using the evacuation slide. During one study using evacuation slides, three individuals, on different occasions, fractured their ankles requiring hospitalisation. All of these individuals were obese, and their weight was believed to have been a contributing factor to their injuries.

A.1.6 **Summary**

From the review of the facilities and methodologies used at CAMI and Cranfield it became apparent that a tool was needed which could be used to allow comparisons to be made between the behaviours obtained from the range of methodologies and facilities available.

Appendix B Experimental work

Experimental work carried out at Cranfield

	Payment system	Variables tested	No. of groups (subject number)	Ages	Equipment/ dimensions	Data
CAA 89019 Aircraft evacuations: the effect of passenger motivation and cabin configuration adjacent to the exit. Supporting video available - Aircraft Evacuation trials	Either 4 ***Competitive evacuations*** (£5 paid to first half of participants to pass through the exits on each evacuation & attendance fee) Or 2 *Non-competitive* £10 attendance money	• Bulkhead widths 24, 30, 36 inches and port galley removed. • Type III exit configurations 3" vertical projection with and without rigid seat back, 6" outboard seat removed, 13", 25" and 34" vertical projection. N.B members of research team operated exits. All evacuations onto ramps.	40 (28 competitive groups/12 non-competitive groups) (2,262)	20-50	Trident aircraft Type III exit: Step-up - 14.5" Step down - 17.5" Internal dimension - 36.5x20" Seating fore and aft of exit	• Mean evacuation times (first 30 participants). • Mean competitive evacuation times for seat rows. • Questionnaire data.
CAA 92002 Aircraft evacuations: a preliminary series of aircraft evacuations to investigate the influence of acoustic attraction signals located beside the exit.	4 ***Non competitive*** evacuations £20 attendance	• Type III exit vertical projection 13" with and without acoustic signal • Type I exit, bulkhead width 30" with and without acoustic signal.	4 (120)	20-50	Trident aircraft Type III exit: Step-up - 14.5" Step down - 17.5" Internal dimension - 36.5x20" Seating fore and aft of exit	• Mean evacuation times (1, 5, 10, 15, 20, 15, 30th passengers)
CAA 92005 Aircraft evacuations: competitive evacuations in conditions of non-toxic smoke	4 ***Competitive evacuations*** (£5 paid to first 75% of participants to pass through the exits on each evacuation & attendance fee)	• Bulkhead widths 20, 24, 27, 30, 36 inches and port galley removed. • Type III exit configurations 6" outboard seat removed, 13", 18", and 34" vertical projection. N.B members of research team operated exits. All evacuations onto ramps.	16 (669)	20-50	Trident aircraft Type III exit: Step-up - 14.5" Step down - 17.5" Internal dimension - 36.5x20" Seating fore and aft of exit	• Mean evacuation times (first 30 participants). • Questionnaire data.

	Payment system	Variables tested	No. of groups (subject number)	Ages	Equipment/ dimensions	Data
CAA 93008 Aircraft evacuations: the effect of a cabin water spray system upon evacuation rates and behaviour. Supporting video available	1 ***Non competitive evacuation*** - participants paid an attendance fee.	• Either a 'dry' evacuation or • 'Wet' evacuation N.B members of research team operated exits. All evacuations onto ramps.	8 (350)	20-50	Boeing 707 aircraft conforming to all CAA regulations	• Mean evacuation times (1, 5, 10, 15, 20, 15, 30th passengers) • Questionnaire data.
CAA 95006 Influence of cabin crew during emergency evacuations at floor level exits Supporting video available	4 Evacuations ***2 Competitive*** (£5 to first 75%) ***2 Co-operative*** (£2.50 to all participants if they evacuated within 90 seconds)	Passengers interacted with one of the following: • 2 Assertive cabin crew • 1 Assertive cabin crew • 2 Non-assertive cabin crew • No cabin crew N.B members of research team operated exits. All evacuations onto slides.	24 (18 through forward exits, 6 through rear exits) (1307)	20-50	Boeing 737 aircraft simulator	• Mean evacuation time per participant (last bonus receiving participant). • Questionnaire data.
TP12832E Aircraft evacuation tests - an initial assessment of the influence of various aisle configurations and lighting conditions under different evacuation scenarios.	4 Evacuations ***2 Competitive*** (£5 to first 75%) ***2 Co-operative*** (£2.50 to all participants if they evacuated within 60 seconds)	• Straight aisles normal lighting • Straight aisles, emergency lighting inside and dark or night conditions outside. • Jogged aisles normal lighting • Jogged aisles, emergency lighting inside and dark or night conditions outside. N.B members of research team operated exits. All evacuations onto slides.	8 (463)	20-50	Boeing 737 aircraft simulator	• Mean evacuation time per participant (last bonus receiving participant). • Questionnaire data.

	Payment system	Variables tested	No. of groups (subject number)	Ages	Equipment/ dimensions	Data
Preliminary review of Type III data collected for Transport Canada 1996	4 Evacuations ***2 Competitive*** (£2 to first 12 passengers) ***2 Co-operative*** (£2.50 to all participants if they evacuated within 45 seconds)	Type III exit evacuations with every permeation of: • Emergency or normal lighting • 13" V.P or 6" outboard seat removed • Cabin crew present or not N.B Passengers operated exits.	4 (95)	20-50	Boeing 737 aircraft simulator Type III exit: Step-up - 13.5" Step down - 15" Internal dimension - 36.5x20" Seating fore and aft of exit	• Egress time for 12th passenger • Exit operation times
CoA No. 9408 The effect on aircraft evacuations of changes to the vertical projection between the seat rows adjacent to the overwing.	4 ***Competitive evacuations*** (£5 paid to first half of participants to pass through the exits on each evacuation & attendance fee)	• Additional Type III exit configurations varying between 6" and 10" outboard seat removed configuration. N.B members of research team removed fabric cover. This method was used due to the difficulty/danger in operating exit with one of the testing configurations	4 (280)	20-50	Trident aircraft Type III exit: Step-up - 14.5" Step down - 17.5" Internal dimension - 36.5x20" Seating fore and aft of exit	• Mean evacuation times (first 30 participants). • Mean competitive evacuation times for seat rows. • Questionnaire data.

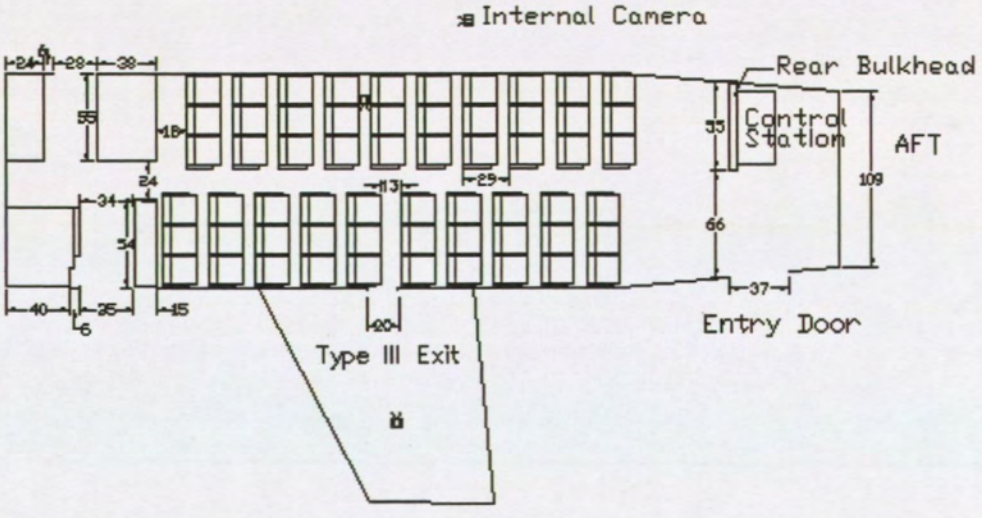
Experimental work carried out at CAMI

	Payment system	Variables tested	No. of groups (subject number)	Ages	Equipment/ dimensions	Data
AM-89/14 The influence of adjacent seating configurations on egress through a Type III emergency exit.	4 ***Non-competitive*** evacuations	• FAA minimum standard (1989) • CAA minimum standard (1989) • 20" vertical projection. Seat encroach no more than 5" into exit opening • Outboard seat removed centred around exit NB Male subject operated exit	4 (127)	17-70	Aircraft simulator Step-up - 18" Step down 22.5" Internal dimension - 38x20 Seating fore and aft of exit	• Mean of individual subject evacuation times
AM-92/27 Effects of seating configuration and number of Type III exits on emergency aircraft evacuations.	4 ***Non-competitive*** evacuations	• 20" vertical projection. Seat encroach no more than 5" into exit opening • CAA minimum standard (1989) • 10" unobstructed gap, seat broken over 15° • 2 Type III exits 6" vertical projection. NB Male subject operated exit	4 (156)	19-61	Aircraft simulator Step-up - 19" Step down 27" Internal dimension - 38x20" Seating fore and aft of exit	• Total time to egress • exit operation • mean time for each subject (3rd-37th) to egress
AM-95/22&25 Aircraft evacuations through Type III exits I & II.	5 ***Competitive*** evacuations (each group took part in three mornings). An unspecified bonus paid to top 3 performers in each group across the trials.	• Passage way widths - 6, 10, 13, 15, 20 inches. • Seat encroachment 5, 10 and 15 inches N.B. exit cover removed from outside	2 (74)	18-62	Aircraft simulator Seating fore and aft of exit	• Total evacuation times (first 35 subjects)

	Payment system	Variables tested	No. of groups (subject number)	Ages	Equipment/ dimensions	Data
AM-96/18 Aircraft Evacuations onto escape slides and platforms I: effects of passenger motivation	5 evacuations either: ***Co-operative*** - orderly fashion but fast. ***Competitive*** - $50 bonus if in first 25% of paxs avg. across 5 trials.	• Type I exits Slide or platform • Smoke or clean air (minimum lighting 0.05 foot-candle) N.B. fabric exit cover removed from outside.	4 (2 competitive/ 2 co-operative groups) (239)	18-44	Aircraft simulator configured as a B-737 All seating aft of exits	• Total evacuation time (first 58 subjects)
Effects of flight attendant location on aircraft evacuations through a Type III exit with differing passenger motivational levels	5 evacuations either: ***Co-operative*** - orderly fashion but fast. ***Competitive*** - $50 bonus if in first 25% of paxs avg. across 5 trials.	• C/C seated inboard one row in front of exit. exit row for evacuation. • C/C seated aft of all pax, moves to exit row conducting evac from there • C/C seated aft of all pax, moves toward exit but conducts evac from behind queue of subjects • C/C aft jumpseat plays no role during evacuation. N.B. fabric exit cover removed from outside.	12 (6 competitive/ 6 co-operative groups) (600)	18-62	Aircraft simulator Step-up - 19" Step down 27" Internal dimension - 38x20" 13" vertical projection. All seating aft of exit	• Mean individual evacuation times (first 46 subjects).

Appendix C Cranfield cabin simulator dimensions

Plan View of Boeing 737-200 Cabin Simulator
Triple Seat Configuration



Appendix D Advertisements

Cranfield Advertisement and volunteer information

Earn up to £30

Aircraft Cabin

✈

Evacuation Trials

The Department of Applied Psychology at Cranfield University is recruiting volunteers to take part in a series of evacuations from a ***stationary aircraft.*** Volunteers will be required on ***one*** occasion for approximately 2½ hours, and will undertake 4 evacuations.

A payment of **£10** will be given to all those who participate. In addition to the attendance payment, volunteers can earn additional money in the form of ***bonus payments***. Two bonus payment systems will be used: competitive and co-operative. In the competitive evacuations the first 75% of "passengers" off the aircraft will receive an additional **£5** for each evacuation. In the co-operative evacuations all of the "passengers" must evacuate the aircraft within a given time. On successful completion of this task passengers will receive a further **£2.50** for each evacuation.

Participants must be between the ages of 20 and 50. On some trial days volunteers will be required to slide down emergency chutes and the trials may be physically demanding, so volunteers should be fit and fall within the following weight dimensions: women must weigh around 12 stone (76.2 Kg), men must around weigh 15 stone (95.25 Kg).

The trials will be held at regular intervals from April 23rd onwards on Tuesday, Wednesday & Thursday evenings.

For further information please contact Ann Cobbett on the following number (01234) 750111 ext. 5229 or complete the slip and send it to the address below:

Ann Cobbett, Department of Applied Psychology, College of Aeronautics, **FREEPOST BS463**, Cranfield University, Bedfordshire, MK43 7BR.

Please send me further information about the aircraft evacuation trials and booking in sheets for _____ people.

Name :_____

Address :_____

_____

_____ Postcode :_____

CAMI Recruitment Advertisement

PART TIME JOB OFFER - $10.50 PER HOUR!!

LOOKING FOR MALES AND FEMALES FOR SIMULATED EVACUATION STUDIES

OBJECTIVES:

- TWELVE (12) GROUPS OF 50 SUBJECTS PER SESSION
- AGE REQUIREMENT: 18 TO 60

PROCEDURES:

- Location of Research:
  Federal Aviation Administration, Civil Aeromedical Institute (CAMI)
  6500 South MacArthur Blvd, Oklahoma City, OK

- STUDY WILL BE CARRIED OUT BY CAMI RESEARCH STAFF. A TRAINED UNIFORMED AIRLINE FLIGHT ATTENDANT WILL ASSIST AS A CREWMEMBER DURING TEST.

- LENGTH OF STUDY: APPROXIMATELY THREE-FOUR (3-4) HOURS DURATION

- COORDINATION WITH THE CAMI CLINIC WILL ASSURE AVAILABILITY OF MEDICAL CONSULTATION, IF THE NEED ARISES.

- SUBJECTS WILL BE BRIEFED UPON ARRIVAL AT CAMI ON TEST DATES.

- UPON CONCLUSION OF TEST, REPORT BACK TO BRIEFING ROOM TO COMPLETE PAY VOUCHERS AND ADMINISTRATIVE PAPERWORK.

PROJECT SCHEDULED TO COMMENCE
FIRST PHASE APRIL 21, 1997
SECOND PHASE MAY 19, 1997

FOR INTERVIEW/ADDITIONAL INFORMATION CONTACT:
Maria Epperson (ATSA Project Manager)
Aero Tech Service Associates (ATSA), Inc.
909 S. Meridian Avenue, Suite 400***Oklahoma City, OK 73108-1639
(405) 946-2886

Appendix E Cranfield Questionnaire

Questionnaire Number 4

Volunteer Number Seat Number

CRANFIELD UNIVERSITY
DEPARTMENT OF APPLIED PSYCHOLOGY

Please complete the relevant sections of the questionnaire and return it to the administration point.

☑ Tick as applicable

1. Did you have any difficulty in undoing your seat belt?

Yes ☐
No ☐➔ go to Q2

If yes, what difficulty did you experience?

_____

_____

2. Which exit did you use?

Left ☐
Right ☐

3. When did you decide to use this exit?

☑ Tick as applicable

- ☐ Before the captain called for us to get out.
- ☐ As I left my seat.
- ☐ As I travelled down the aisle.
- ☐ When I reached the front of the cabin.
- ☐ Other. Please specify:

_____

_____

4. For what reasons did you chose this exit? ☑ Tick as many as applicable

- ☐ I was called to this exit.
- ☐ I was pushed by cabin staff.
- ☐ It was the only available exit.
- ☐ The other exit was blocked.
- ☐ Other. Please specify: _____

5. Did you use the exit the member of cabin crew asked you to use?

Yes ☐
No ☐
Not applicable ☐

6. Did you choose an exit originally and then change your mind?

Yes ☐
No ☐➔ go to Q.7

If yes, what made you change your mind?

_____
_____
_____
_____

7. Did anything or anyone hinder your access to or escape through the emergency exit?

Yes ☐
No ☐➔ go to Q.8

If yes, **who** or **what** hindered your progress?

_____
_____

Additionally, **how** did they hinder your escape?

_____
_____

8. Did anything or anyone aid your access to or escape through the emergency exit?

Yes ☐
No ☐ ➔ go to Q.9

If yes, who or what helped your progress?

_____
_____

Additionally, how did they help your escape?

_____
_____
_____

9. Did the cabin crew aid your escape?

Yes	☐
No	☐➔ go to Q.10
No cabin crew	☐➔ go to Q.11

If yes, how did they aid your escape? ☑ Tick as applicable.

- ☐ Indicated the exits in use.
- ☐ Shouted Instructions.
- ☐ Pushed passengers through the exits.
- ☐ Only physically helped passengers when in danger.
- ☐ Other. Please specify:

_____

_____

10. Do you think there was anything more the cabin crew could have done to aid your escape?

Yes	☐
No	☐➔ go to Q.11

If yes, what could they have done?

_____

_____

11. What was your experience of the evacuation slides?

_____

_____

12. Did you experience any delay in merging with the aisle queue?

Yes	☐
No	☐

13. Did you hurt yourself in any way whilst evacuating.

Yes	☐
No	☐➔ go to Q.14

If yes, how did you injure yourself? _____

_____

14. On a scale of 1 to 10, please indicate the difficulty of reaching the exit.

1	2	3	4	5	6	7	8	9	10
Easy									Difficult

15. On a scale of 1 to 10, please indicate the difficulty of using the evacuation slides.

1	2	3	4	5	6	7	8	9	10
Easy									Difficult

16. Are there any further points you would like to make?

_____

_____

_____

_____

Appendix F Participant evacuation information sheets

Cranfield participant evacuation information sheets

AIRCRAFT CABIN EVACUATION TRIALS

The Department of Applied Psychology is conducting research for the European Aircraft Manufacturers and operators. The aim of the research is to ensure that the cabin features do not hinder passengers evacuating an aircraft in an emergency.

Volunteers will be required for approximately three hours on one occasion, in which time they will undertake four evacuations from a stationary aircraft and complete some questionnaires.

Participants will be required to slide down emergency chutes and the trials may be quite physically demanding. Volunteers must therefore be between the ages of 20 and 50. Volunteers must be fit and weigh 12 stone or less for women, 15 stone or less for men. Volunteers must also have no history of the following illnesses.

Heart disease	Ankle Swelling	Asthma
High blood pressure	Depression	Bronchitis
Fainting or blackouts	Anxiety	Breathlessness
Diabetes	Other nervous diseases	Chest trouble
Epilepsy or fits	Fear of enclosed spaces	Allergy
Deafness	Brittle bones	Lumbago sciatica
Chronic back pain	Fear of heights	Any other serious illness

Additionally, those women who think they may be or are pregnant should not participate.

Prior to the evacuations all volunteers will be given a brief medical examination, weighed, measured for height and asked to complete a questionnaire about themselves.

A payment of £10 will be given to all those who participate in the trials. In the first two evacuations 75% of "passengers" off the aircraft will receive an extra £5 for each evacuation. The two remaining evacuations will require all of the "passengers" on the aircraft to evacuate within a given time. On successful completion of this task passengers will receive a further £5, it is therefore possible to earn a maximum of £25.

If having read this document thoroughly you wish to participate in the cabin evacuation trials, please complete the attached form and return it to the Department of Applied Psychology.

✈AIRCRAFT CABIN EVACUATION TRIALS✈

Firstly it is essential that you read this document carefully and fully understand its contents before signing the attached consent form. If you feel that after reading this document you do not wish to take part, please do not feel obliged to do so.

Volunteers must also have no history of the following illnesses:

Heart disease
High blood pressure
Fainting or blackouts
Diabetes
Epilepsy or fits
Deafness
Chronic back pain
Ankle Swelling
Depression
Anxiety
Other nervous diseases
Fear of enclosed spaces
Brittle bones
Fear of heights
Asthma
Bronchitis
Breathlessness
Chest trouble
Allergy
Lumbago sciatica
Any other serious illness

Additionally, women who think they may be or are pregnant should not participate.

All those who are undergoing any medical treatment or who have recently undergone surgery should consult the medical officer on duty before agreeing to participate.

2) Safety

To ensure the safety of all those involved, a number of precautions have been taken:

a) If an evacuation of the aircraft is necessary you may be required to use the emergency slides. These slides have been specially fitted with a speed resistant surface to slow down passengers descent. Netting and padding has been fitted around the emergency slides to ensure that injury is minimised in the unlikely event of an accident.

b) Some fitments within the cabin have been padded, thereby reducing risk of injury.

c) Three members of the Cranfield staff are present on the aircraft at all times: these individuals will make themselves known to you. All carry alarms, if you hear an alarm this is a signal to HALT. This indicates that a problem has occurred, and the trial has therefore been stopped.

d) A doctor and a number of people with first aid experience are on hand, if you feel the need to consult one of these individuals do not hesitate to do so.

PAYMENT SYSTEM

As you have previously been informed, you will receive £10 for participating in the trials. The first 75% of the "passengers" off the aircraft on each of the four trials will receive an extra £5, it is therefore possible to earn a maximum of £30.

To ensure that all individuals have an equal opportunity to obtain this money, each seat has been rated as to its proximity to the door (1 being very close, 4 being the most distant). Thus you will be placed in a different seat on each trial.

After reading this document carefully, please complete the attached questionnaire about yourself and your health. You will then be called by Cranfield Staff to be weighed and have your height measured. After this you will be showed to the doctor for a brief medical. The questionnaire is to ensure that you do not have any health problems which would indicate that you should not take part in the evacuations.

CRANFIELD INSURANCE INFORMATION

You are advised that the above test is undertaken at your own risk. The university has arranged personal accident insurance, which provides benefit in the event of you sustaining accidental bodily harm. No further claims are admissible, nor shall the University be held liable in the event of any accidental injury or damage outside these benefits.

Scope of Insurance Cover: Accidental Bodily Injury

Benefit:	Temporary Total Disablement (or where not otherwise gainfully employed, £25 per week) (Maximum 104 weeks and excluding the first two weeks each and every claim)	£50 per week
	Permanent Total Disablement	£20,000
	Loss of One or Two Limbs	£20,000
	Permanent Total Loss of Sight of One or Two Eyes	£20,000
	Death	£20,000

Cranfield University

Department of Applied Psychology
Consent Form

I, _____, have read and completely understand the information sheets and believe that my health and fitness are good enough for me to cope with the work involved in the cabin evacuation trials which are to take place today.

Delete as appropriate:

I am not receiving any medical treatment

I am receiving medical treatment

Please specify: _____

_____

SIGNATURE: _____

DATE: _____

Height _____

Weight _____

Forward bend:_____
Side bend - left _____
- right _____
Arms folded across chest? Y/N

MEDICAL CLEARANCE

Dr: _____ SIGNATURE: _____

CAMI participant evacuation information sheets

Initial Subject Briefing

Welcome to the Protection and Survival Laboratory of the Civil Aeromedical Institute. Today you will be participating in a research project designed to investigate ways in which to improve safety in air travel. Your participation is greatly appreciated and of the utmost importance. You can take a great deal of satisfaction in knowing that the results of your actions today may save lives of air travelers in the future. The area of concern for today's trials is emergency aircraft evacuations, or in other words, getting out of the aircraft rapidly. Emergency evacuations are performed on real aircraft when an accident or malfunction occurs which demands that passengers leave the aircraft as quickly as possible for their own safety.

In today's experiment, you will be required to sit in an airplane seat in our aircraft mock-up, then perform a series of 5 simulated emergency evacuations. You may be called upon to remove an escape hatch that weights approximately 30 pounds. You will be required to leave your seat and travel to the exit for escape. The exit is an opening 38 inches high by 20 inches wide. The sill of the exit is 19 inches above the floor, and 27 inches above the ground outside the aircraft. After re-entering the facility we ask that you take the boarding card that will be supplied to you, then take the seat that is listed on the card. You will sit in a different seat each time you evacuate.

To participate in the tests today you must not have any physical disabilities that would prevent you from being able to get out of your seat, move rapidly, and step over and through the exit. You must have no illnesses such as heart disease, or other conditions such as pregnancy that restrict your ability to exercise. You must not be under the influence of alcohol or any drug, including prescription drugs. If this applies to you, once again, please notify one of the researchers. Although no real danger will exist in our trials today, we want you to understand the unlikely hazards associated with emergency evacuations may include, but are not limited to: cuts, bruises, and broken bones. These injuries can occur from bumping into seats, or other cabin items, and from slipping, tripping, or falling. Still, we ask that you perform as rapidly as possible in an effort to collect realistic data.

In a moment we will provide you with an informed consent form. This is a document that lets us know that you have been told about the tests, understand the procedures, and are willing to participate. We will read the consent form aloud and answer any questions you may have. You should already have a subject information form. Please make sure you have recorded your subject number and your vest number on this form. After completion of all the trials, return to this room to complete your pay voucher. At all times, please keep in mind the seriousness of this endeavor, and how important it is to help save lives.

For subjects in the high motivation groups:

Twenty-five percent of you will receive an additional $50.00 for your participation today. In order to receive this bonus money, you must be among the first 25% to get out the exit, averaged over all 5 trials today. Sometimes you will be seated close to the exit, and sometimes far away. However, since the seating placement is randomized, everyone has a statistically equal chance to getting the bonus money. But, please remember, since this will be an average of the five trials, it is

very important to get to and out the exit as quickly as possible, no matter how far away from the exit you are at the start. Success depends on getting out ahead of as many others as possible. Although we want you to go as fast as possible, do not trample, knock down, or used excessive physical pushing and shoving when manoeuvring to the front. We are filming these evacuations, and if it is determined that you caused harm to another person, you will not receive the bonus. Are there any questions?

Individual's Consent to Voluntarily Participate in a Research Project

I, _____, understand that this research project entitled *Passenger Escape from Aircraft using a Type III Exit* is being sponsored by the Federal Aviation Administration and is being directed by Mark H. George of the Civil Aeromedical Institute (CAMI). I have been hired by ATSA, Inc. to participate in this study.

PURPOSE: I understand that this project is designed to look at ways to improve aircraft safety. The specific area of concern is escape from airplanes through a Type III emergency exit. These exits, usually located in the over-wing area, are used on aircraft to allow passengers to get out of the cabin when an accident or malfunction occurs. There are federal standards governing Type III exits, and this study will help identify methods of using the exits in a more beneficial way.

DESCRIPTION OF STUDY: I understand that this research will be conducted using the CAMI Aircraft Cabin Evacuation Facility (evacuation simulator), and will involve 600 subjects, each of whom will be required to evacuate the simulator cabin 5 times. I will be seated inside the simulator, with my seatbelt fastened, then, when the start signal is given, will unbuckle my seatbelt, and move quickly to, and through the exit to the outside of the simulator. I understand that after exiting the simulator, I must move out of the way of others coming out behind me. It is important to always follow the directions given by the research team and the flight attendant. Between trials, I will remain outside the facility until receiving instructions from the research team. [I understand that I am in a research group that is being offered additional compensation of $50.00 for the first 25% of the subjects that get out of the aircraft simulator, averaged over all 5 trials.] I understand that all the trials I participate in will be videotaped.

RISKS: I understand that there are possible injuries that I could receive from my participation in this study. Such injuries could include, but are not limited to, bruises, lacerations, strains, sprains and/or broken bones. These usually result from slipping, tripping, falling, jumping onto other subjects, or being jumped on. In previous studies at this facility the most serious injuries have been minor lacerations, contusions, strains and sprains. These were principally caused by lack of subject attention, and participation by subjects whose day-to-day activities do not include physical exertion. The estimated incidence of such minor injuries is typically less than 1 per hundred persons crossing through a Type III exit. Some of the subject groups participating in Type III evacuation drills for purposes of education or research have had *no* injuries, even with repeated exposure to the evacuation trials. I have been briefed and shown pictures about how to properly accomplish these activities, and I have had opportunities to ask any questions I have concerning the research and my participation. All my questions have been answered to my satisfaction.

Subject's Initials _____

SUBJECT RESPONSIBILITIES: I certify that I have no physical disabilities that would prevent me from being able to evacuate an aircraft cabin, nor any illnesses such as heart disease, or other conditions, such as pregnancy, that restrict my ability to exercise, move nimbly, or which could make this activity additionally hazardous.

I further certify that I am NOT under the influence of any medication or chemical substance, including alcohol that may compromise my own safety or the safety of others directly associated with the research. I also acknowledge that I must withdraw NOW from participation in the project if I have any such condition or am under any such influence.

I agree to allow still photographs and/or videotapes to be made of me as required during the research, with the understanding that these records are the property of the U.S. Government, and that I am not entitled to monetary or other benefits, now or in the future, for the use of this material. I understand that I will not be identified by name in any pictures or videotapes of me that are used.

I understand that it is important to be accurate and honest with my responses on the subject questionnaires and any other questions the researchers may have about the research and my participation during the project.

I understand that it is very important to pay attention and follow all instructions from the researchers. I understand that I must not trample or knock down any other person, or use excessive physical pushing and shoving while manoeuvring to the front. I hereby release the FAA from any and all claims that may arise as the result of my own negligence and/or failure to follow the instructions of the CAMI personnel.

Subject's Initials _____

BENEFITS: The major benefit to me will be my payment from ATSA, Inc. The major benefits to the FAA and the flying public will be improved safety on commercial aircraft.

COMPENSATION AND INJURY: I have been made aware that accident insurance coverage for this activity is provided only through the **State of Oklahoma Workers Compensation Insurance Fund** in relation to my employment for this project by ATSA, Inc., and that necessary immediate care of any resultant medical problems may be provided by the CAMI Clinic until, or unless, transportation to another medical facility is obtained. Follow-on care would be provided by local clinics and hospitals that would require verification of my insurance. I agree to provide CAMI, if requested, with copies of all insurance and medical records arising from any such care for injuries/medical problems.

Subject's Initials _____

SUBJECT'S ASSURANCES: I understand that my participation in this study is voluntary. I have not given up any of my legal rights or released any individual or institution from liability for negligence. I understand that I may withdraw from this study at any point during or between trials without penalty or loss of benefits to which I am otherwise entitled. I understand that if new findings develop during the course of this research that may relate to my decision to continue participation, I will be informed.

Subject's Initials _____

I understand that all records of this study will be kept confidential, and that I will not be identified by name or description in any reports or publication about this study, except where photographs may include my picture. If I have questions about this study, or need to report any adverse effects from the research procedures, I will contact Mark George at 405-954-5522.

I have read this consent document. I understand its contents, and I freely consent to participate in this study under the conditions described. I understand that I may request a copy of this consent form.

Do you understand that participation in this research project involves a risk of injury and that there are things you can do to reduce that risk?

(Initial one) YES _____ NO_____

_____ _____
Research Subject Date

_____ _____
Investigator Date

_____ _____
Witness Date

Appendix G Participant briefing transcripts

Cranfield participant briefing

Good evening ladies and gentlemen, thanks very much for turning up and agreeing to help us this evening, what I would like to do now is to spend a few minutes doing two things, firstly just giving you a little bit of background about what these tests are about, how we come to be doing them here, and what we are trying to find out and then secondly what in practise is going to happen and then lead you through the hanger and on board our aircraft.

So why are we doing these studies? Well some of you may have been to help us before but for those of you who haven't, since 1988 Cranfield have been helping the regulatory bodies, in other words the officers that make the safety regulations, to determine what they can do to increase the chance of people surviving an aircraft accident. Aircraft accidents are very infrequent but when they do happen, if a fire occurs, there is frequently loss of life and the reason that can occur, is because typically once the fire has started there is only usually two minutes in which the conditions in the cabin remain survivable, so we have to make sure that we can get everybody out in less than two minutes and I am sure you can appreciate that in some of these big aircraft on which you fly that can be quite a challenge. So all the time we at Cranfield are doing testing work to see what will happen if we change something, will that help people get out more quickly? Should we change some of the aircraft structures? Should we change what the cabin staff do? What can we change to try and improve the situation? and what can we learn about what is stopping people getting out in difficult situations?

Tonight we will be doing a total of four evacuations from the aeroplane and the arrangement that we have made is that we will pay you £10 each for showing up here tonight. In the first two evacuations the first three quarters of you out, of whichever exits are open will receive £5. The payment system is slightly different in the last two evacuations; during both evacuations if you all successfully get out of the aircraft in under 90 seconds you will all receive a further £5. Now 90 seconds might sound very short, but I can assure you that if you really get yourselves organised it is do-able, it's been done, it is a real challenge, and I want you to think also when you are coming out well what would I be like if there was a fire behind me and think about that situation, because that is the situation we are trying to really study. That's the payment system and you all have the opportunity to earn £25.

You may have been wondering why we have been photographing you, measuring you and taking all this detailed questionnaire information, that is because in addition to the overall time it takes to get people out we are interested in what sort of people are able to get out quickly, can big people get out faster than smaller people? Can younger people get out faster than older people? All of this information will be used to help to develop a mathematical model of what determines how quickly people can get out of an aircraft accident, so that is why we were collecting all of that information.

So when we have finished talking here, what I will ask you to do and don't just get up as I've a few more minutes to explain, leave your clipboards here and your coats and so on and go out into the hanger wearing the numbered bib you have been given. You will then be shown to our half of a 737. Our cabin staff here, of which Ann is a member, will show you to your seats, the seat you sit in for the first evacuation is the seat number on the bib which you are currently wearing, so take a note of your number that is the seat you will be sitting on for the first evacuation, once you are on board and everybody is seated, you will be given a very typical pre-flight briefing, the sort of briefing you have when you go on a flight somewhere, demonstrating how to do the seat belts and so forth but we are not actually giving you duty free drinks on this flight I am afraid, but you will then hear the

sound of the engines sound up, things starting to happen and eventually the instructions from the captain "Undo your seat belts and get out", and when you hear that instruction, that is your cue to move and you are to make towards whatever exits seem to be being opened and indicated to you.

When you get to the exit you will find there are slides, the aeroplane is as high as aeroplanes are, and the are slides which take you down to the ground, these slides are just typical of the ones that are used on real aircraft in real emergencies and I wanted to talk to you a little bit about how to come down the slides because it is very easy to injure yourselves going down the slides. There have been injuries going down slides and we don't want you to injure yourselves and if you do as I say you won't but it is very important that when you get to the door of the aircraft you will stand on the sill in front of you, you will see the slide and all you do is cross your arms and literally jump forward and sit down onto the slide, just as if you are jumping down onto a trampoline, it is soft and you will just then slide rapidly down to the bottom. When you sit on the slide, most important to keep your feet together with your toes up, don't try and slow yourself down by letting your foot come out or by trying to dig your heels in, you won't slow yourself down but you will hurt yourself, you will go down quite quickly but don't worry about it because at the bottom we have got our friendly fire officers there already to pick you up and move you along.

When you go onto the slide make sure you don't go on so close together that you crash into some body else, don't try and go down two at once, but do go down as quickly as you feel you safely can after the person in front. When you get to the bottom of the slide, as I said, you will be helped up by our fire men, you will then be shown to an area where you must wait until you are told to move. When you get to the bottom of the slides you will see that there are people there with tickets and I want you to take a ticket, you'll be able to recognise them because of these delightful blue sweatshirts they are all wearing. When the evacuation has finished you will be shown were to leave your numbered bibs and then you can take the ticket if you were lucky enough to get one this time to the desk and swap it for a five pound note.

Then if you come back here you fill in your next questionnaire, which is blue. Once you have done this you come out back into the hanger, we give you a new bib with a new seat number and we all go back on board and start the process again, and as I have said we are doing a total of four evacuations. So that is the basic procedure, just a couple of general points.

Firstly, I know there is al lot of questionnaire information here, but it really is important and it really is needed so please do bear with us and fill it in as best you can, it is quite important that we have this information as accurately as we can because all the time we are trying to learn more about things we need to look at and things that might possibly lead to an improvement. We obviously hope that there won't be any problems, but should there be a problem on the aircraft, suppose somebody falls and somebody else trips over them and people are in danger of being hurt then we would obviously stop the evacuation, if we have to stop the evacuation we will sound an alarm, and I would like to just demonstrate to you now so you know what to expect, it is terribly loud, you may want to protect your ears, *sounds rape alarm,* you will be in no doubt if you hear that noise, if you hear that noise just stop and wait for instructions, it means that a problem has occurred, we have to say that we hope that you don't let a problem occur because obviously if you do and we have to use this no bonus payments will be made, so make sure we don't have to, please look after each other and be careful whilst at the same time really trying to get out as quickly as you can.

If anyone starts to become concerned and decides they want to drop out or they have had enough of this, that is perfectly all right, just come and have a word with me, we'll still pay you for coming along, not everybody enjoys doing these things, and if you find you are starting to get worried about going down the slides or something, just come and say and we'll arrange for you to drop out.

Another point is your personal effects, we would ask you please not to take part in this wearing very expensive watches because straps sometimes get broken and they could get trodden on, if you can possibly manage without your glasses, if you need them for the questionnaires, if you give them to me, or if you come to me when you are about to board the aircraft I'll show you where you can leave them and where they can be collected afterwards because we ask you not to go down the slides with glasses on unless you really can't see at all without them, just in case they get knocked off and broken or so forth. Please don't wear any long dangly chains or ladies, long dangly earrings or anything that could possibly either get damaged or injure you or somebody else and a further thing, as you are going to be going down the slides fairly fast it is obviously not advisable to go down with a large bunch of keys or a wallet in your back pocket as they could make quite a permanent impression, so it's just a question of being practical and sensible. If you have any of these items and you are not going to take them on the aircraft, Ann here has some brown envelopes, when I have finished talking if you come and get a brown envelope, out your name on the envelope, put whatever items you have in the envelope, seal it up, give it back to Ann, we will keep them safely for the duration of the exercise and then you can pick them up at the end.

Does anyone have any questions? No one has decided to drop out already, I've put them off, no, jolly good, OK well if you need an envelope, if you would to come forward to Ann, but if you don't or when you are ready if you just come with me and we will go out into the hanger.

CAMI participant briefing transcript

Subject/Safety Briefing

The experiment that we will be conducting today is very important to the future of aviation safety. To insure that you receive all the information that you will need, please remain quiet at all times while you are in this facility and wait for instructions from the researchers.

Emergency evacuation of aircraft requires passengers to get out of their seats, hurry to the exit, then go outside as rapidly as possible, for their own safety. Although we encourage you to move *very* quickly, please do not trample anyone during the tests. Even though these tests only simulate real emergency evacuations, the potential hazards are similar to those you could experience in an actual event. While we have taken every foreseeable precaution to insure your personal safety, occasionally the unexpected happens. If a potentially unsafe condition occurs, a member of the research team will stop the evacuation by sounding this alarm bell (sound alarm). If you hear this alarm at any time during the experiment, immediately stop moving and wait for further instructions.

In preparation for the trials, please make sure your seatbelts are fastened securely around you. To fasten your seatbelt, insert the metal fitting into the buckle (demonstrate). Tighten the belt by pulling on the loose end of the strap. To release the belt, lift up on the buckle flap.

The only emergency exit available today is the window exit clearly marked on the right side of the airplane. Please take a moment to look around you to see where the emergency exit is located.

There will be uniformed crewmembers present in the cabin today. They are in charge of the cabin. Please follow any instructions that they may give you.

You will be seated in a different seat for each of the 5 trials today. A boarding card with a seat assignment on it will be presented to you each time you reboard the aircraft. Please sit in that seat. After you evacuate the aircraft, move away from the facility. A researcher will be there to meet you.

For all trials:
Please make sure your seatbelts are securely fastened. In a short time this buzzer will sound (sound buzzer). That will signal the beginning of the test. When you hear this buzzer, immediately unbuckle your seatbelt, get up, and leave the aircraft through the exit as rapidly as you can. If you have any questions, please ask one of the researchers.

For subjects in the high motivation groups:
Twenty-five percent of you will receive an additional $50.00 for your participation today. In order to receive this bonus money, you must be among the first 25% to get out the exit, averaged over all 5 trials today. You will be in a different seat for each evacuation. Sometimes you will be close to the exit, and sometimes far away. However, since the seating placement is randomized, everyone has a statistically equal chance of getting the bonus money. But, please remember, since this will be an average of the five trials, it is very important to get to and out the exit as quickly as possible, no matter how far away from the exit you are at the start. Success depends on getting out ahead of as many others as possible. Although we want you to go as fast as possible, you must not trample or knock down any other person, or use excessive physical pushing and shoving while maneuvering to the front. We are filming these evacuations and if it is determined that you caused harm to another person; you will not receive the bonus. Are there any questions?

Appendix H Cranfield emergency scenarios

Cranfield Evacuation Scenarios

Scenario 1

After pre flight briefing " Ladies and gentlemen this is your captain speaking. We are currently in a queue of aircraft awaiting take off and should be airborne in a few minutes."

Engine noise for approximately 20 seconds then the command "Undo your seat belts and get out".

Scenario 2

During the pre flight briefing, after the seat belt demonstration the command "Undo your seat belts and get out" is heard.

Note: this scenario is used when only a single exit is available.

Scenario 3

Following the pre flight briefing a cabin check is made.

A short engine noise lasting approximately 30 seconds is heard then the command "Undo your seat belts and get out"

Scenario 4

Following the pre flight briefing a cabin check is made.

A long engine noise lasting approximately 60 seconds is heard culminating with a large bang then the command "Undo your seat belts and get out"

Appendix J Behavioural evaluation tool one

Independent raters were asked to watch the videos and 'count' the number of passengers using each of the key behaviours recording the number of instances and their intensity.

	Intensity				
Behaviour	Mild pushing		→		Very physical
Running to exits					
Breaking seats forward					
Climbing across the seats					
Hanging/holding overhead lockers					
Pulling other passengers clothes					
Pulling/holding other passengers back					
Pushing/barging past other passengers					
Climbing over other passengers					
Refusing/blocking passengers trying to enter line					
Falling over or being pushed over					
Movement to exit using space between seats and fuselage					

Appendix K Behavioural evaluation tool two

Camera Location	Behaviour type rated		
Within cabin	1	jumping up and moving rapidly	0 - 5
	2	pushing, pulling, falling, blocking	0 - 5
	3	climbing seats and other pax, hanging on lockers	0 - 5
At bulkhead	4	intensity of pressure	0 - 5
	5	speed of passage	0 - 5
Onto slide	6	amount of hesitation	0 - 5
	7	speed of passage	0 - 5
On ground	8	amount of falling	0 - 5
	9	speed of get away	0 - 5
At Type III exit	10	intensity of pressure	0 - 5
	11	speed of passage	0 - 5
Onto wing	12	amount of falling	0 - 5
	13	speed of get away	0 - 5
General	14	overall urgency of evacuation	0 - 5
	15	overall intensity of behaviour	0 - 5

Each tape will be stopped every 5 seconds for the rater to indicate against the behavioural items for that tape their evaluation of behaviour during the previous 5 seconds from 0 - 5 (0 = no instances of behaviour, 5 = extreme behaviour).

Appendix L Behavioural evaluation tool three

Inside Cabin

Speed	**0**	No movement at all
	1	Very slow shuffle
	2	Slow walk
	3	Normal walking pace
	4	Fast walking
	5	Moving rapidly/ running
Pushing	**0**	No contact at all
	1	Light touch (follow my leader)
	2	Light push to hurry person in front
	3	Mild physical bodily contact (non aggressive)
	4	Aggressive physical contact
	5	Intense aggressive physical contact (no care about injury)
Climbing on seats	**0**	No climbing
	1	Passengers who amble over seats (no motivation to 'get in front')
	2	Passengers with quicker movement over seats BUT still no motivation to 'get in front'
	3	Passengers who climb quickly to instead of queuing
	4	5+ passengers who climb quickly instead of queuing
	5	Passengers aggressively climbing/hanging onto lockers, desperate to get out

At Type III exit

Pressure/ Blocking	**0**	No block or pressure
	1	Mild contact but little if any delay to movement through exit
	2	Mild contact as paxs come out, causing slower movement
	3	Multiple passengers squeezing out
	4	Several passengers stuck in exit managing to extricate themselves with great difficulty (or help of crew/firemen)
	5	Completely blocked (no movement)
Speed of Passage	**0**	No movement at all/ blocked
	1	Very slow (1 passenger every 5 secs)
	2	Slow flow (1 or two passengers every 5 secs)
	3	Medium flow no urgency to escape (3 passengers every 5 seconds)
	4	Moving quickly no delay/hesitation (4 passengers every 5 seconds)
	5	Moving rapidly with urgency (4+ passengers every 5 seconds)
Falling	**0**	No falling
	1	Limited number of passengers catching foot on step up and stumbling onto wing
	2	Limited number of passengers catching foot on step up and falling onto wing
	3	Large proportion of passengers falling to floor as moving through exit
	4	Large proportion of passengers falling hard to floor as moving through exit
	5	Passengers stuck in exit, majority falling to floor as method of exit
Movement away from Exit	**0**	No movement at all, exit blocked
	1	Very slow shuffle
	2	Slow walk
	3	Normal walking pace
	4	Fast walking
	5	Moving rapidly/ running
Overall urgency to escape	**1**	No urgency perceived
	2	Limited urgency but no aggression
	3	Need to escape quickly but not too urgently (no threat to life perceived)
	4	Urgent and motivated behaviour
	5	Intensely urgent and desperate 'life in exceptional danger'
Overall Intensity of Behaviour	**1**	Very Mild/slow - no pushing
	2	Disciplined ordered behaviour
	3	Urgency but non aggressive behaviour
	4	Urgent with some aggression
	5	Extreme aggressive behaviour

Bulkhead

Pressure/ Blocking	**0**	No block/pressure
	1	Mild contact but little if any delay to movement through bulkhead
	2	Mild contact with other paxs, causing slower movement through blk/hd
	3	Multiple passengers squeezing through
	4	Several passengers stuck in bulkhead extricating themselves with great difficulty (or help of crew)
	5	Completely blocked (no movement)
Speed of Passage	**0**	No movement at all/ blocked
	1	Very slow (passengers being prised out by crew)
	2	Slow flow passengers shuffling
	3	Medium flow (3 passengers every 5 seconds)
	4	Moving quickly (fast walk) no delay/hesitation
	5	Moving rapidly/running
Hesitation at slide	**0**	No hesitation jumping onto slide as soon as reaching exit
	1	Momentary hesitation (tenths of a second)
	2	Pausing before jumping
	3	Short delay before jumping
	4	Long hesitation possibly waiting for slide to clear
	5	Complete refusal to jump
Falling	**0**	No falling
	1	Limited number of passengers stumbling off slide
	2	Limited number of passengers falling to floor
	3	Majority of passengers stumbling off slide
	4	Majority of passengers falling to floor
	5	Slide blocked due to passenger pile up
Movement away from Exit	**0**	No movement at all
	1	Very slow shuffle
	2	Slow walk
	3	Normal walking pace
	4	Fast walking
	5	Moving rapidly/ running
Overall Urgency to escape	**1**	No urgency perceived
	2	Limited urgency but no aggression
	3	Need to escape quickly but not too urgently (no threat to life perceived)
	4	Urgent and motivated behaviour
	5	Intensely urgent and desperate 'life in exceptional danger'
Overall Intensity of Behaviour	**1**	Very Mild/slow - no pushing
	2	Disciplined ordered behaviour
	3	Urgency but non aggressive behaviour
	4	Urgent with some aggression
	5	Extreme aggressive behaviour

Appendix M Rating sheets

Behavioural Checklist Type III

Date: _____
Rater: _____
Video No.: _____

0 = no instances of behaviour 1 = mild (slow) behaviour 5 = extreme (fast) behaviour

	Behaviour rated - intensity 0-5					
	Speed out of seat and movement to exit	Pushing, pulling	Climbing seats, hanging on lockers	Intensity of pressure at exit	Speed of passage through exit	Amount of falling
Time in seconds						
5						
10						
15						
20						
25						
30						
35						
40						
45						
50						
55						
60						
65						
70						
75						
80						
85						
90						

Behaviour rated - intensity 0-5

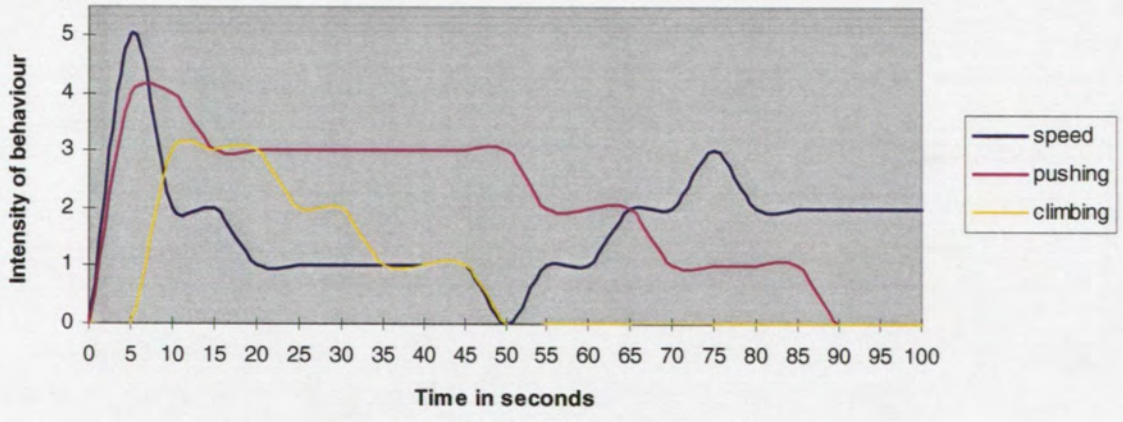
	Speed of movement away from exit
Time in seconds	
5	
10	
15	
20	
25	
30	
35	
40	
45	
50	
55	
60	
65	
70	
75	
80	
85	
90	

Overall rating of passenger urgency of evacuation (1 = no urgency, 5 = extreme urgency): _____
Overall rating of passenger behaviour (1 = mild behaviour, 5 = extreme behaviour): _____

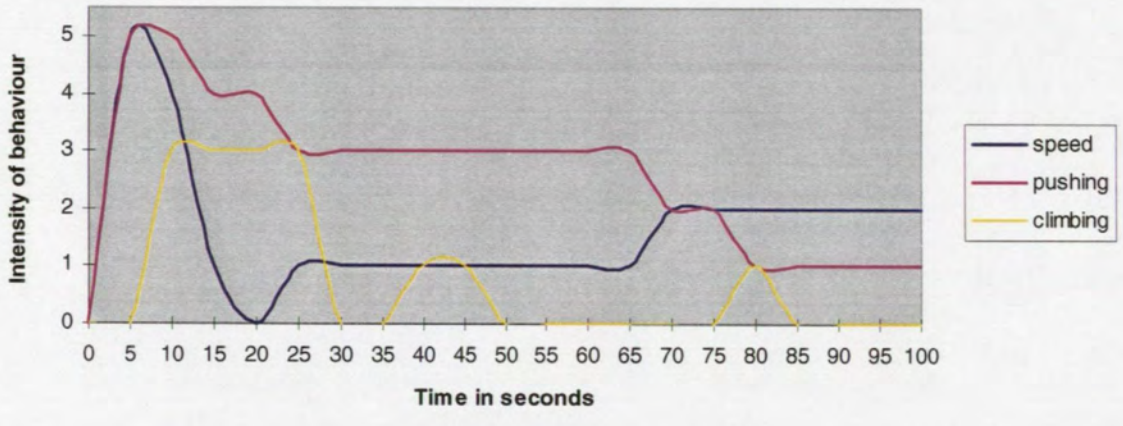
Appendix N Ratings

Competitive 50% - within cabin

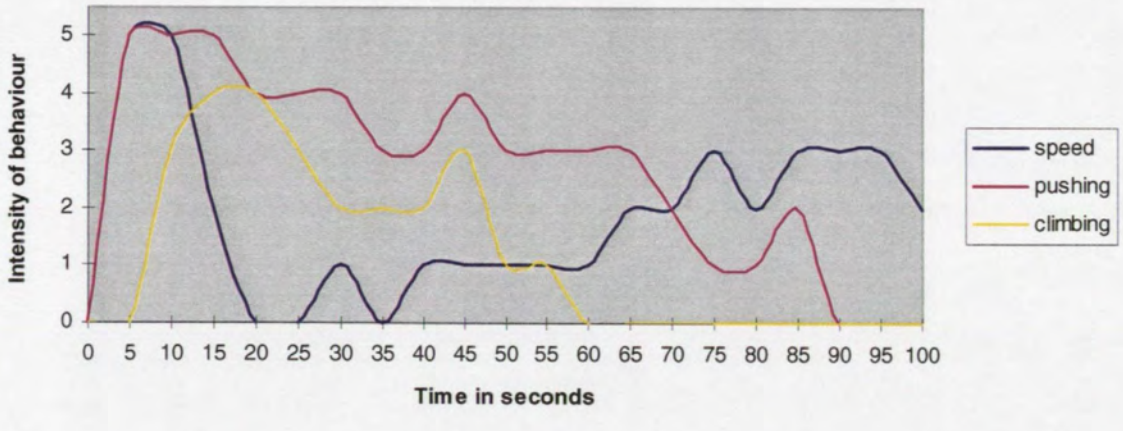
Rater one - cabin



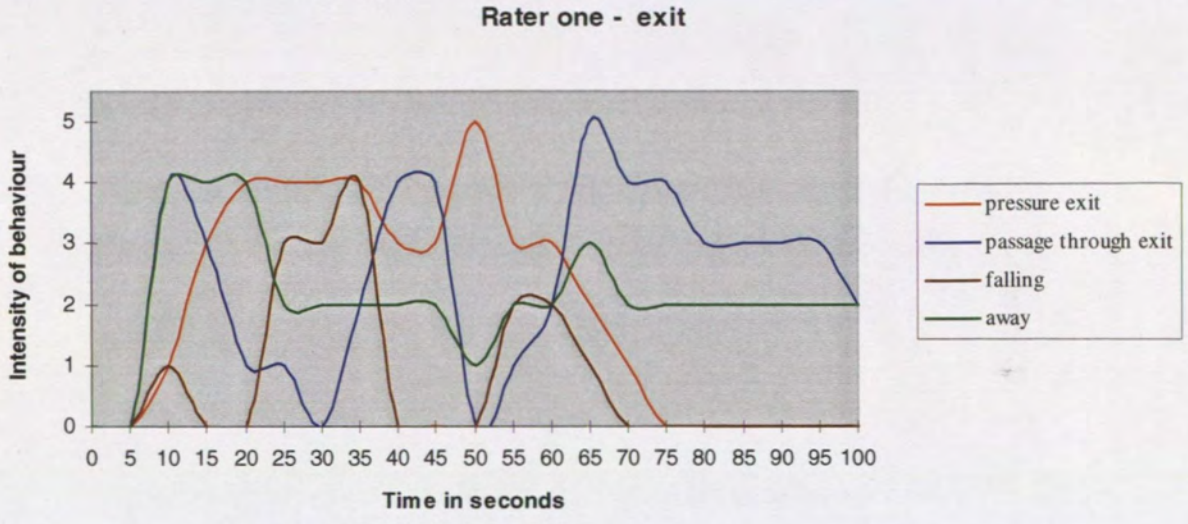
Rater two - cabin

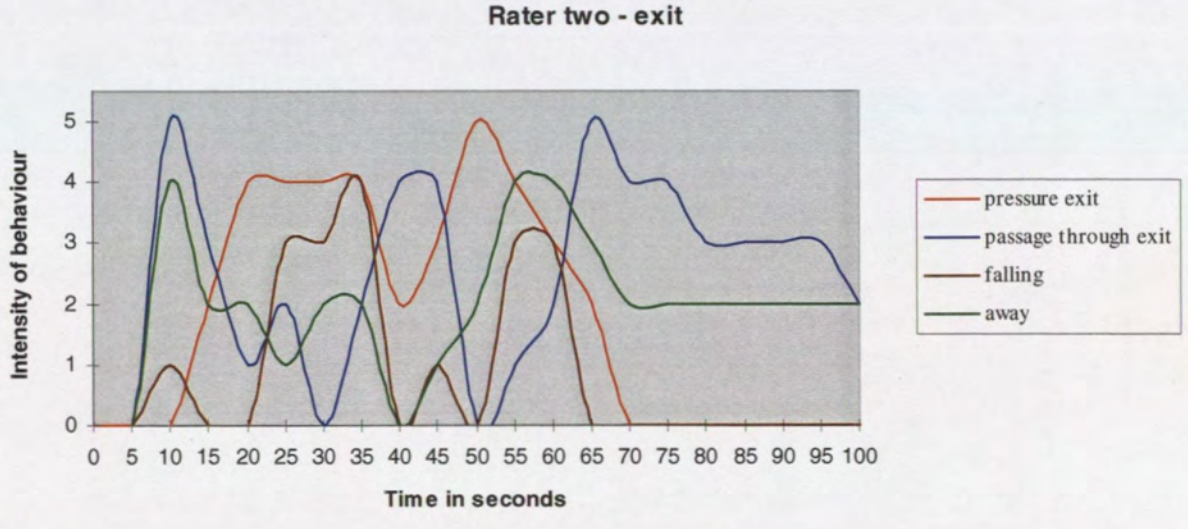


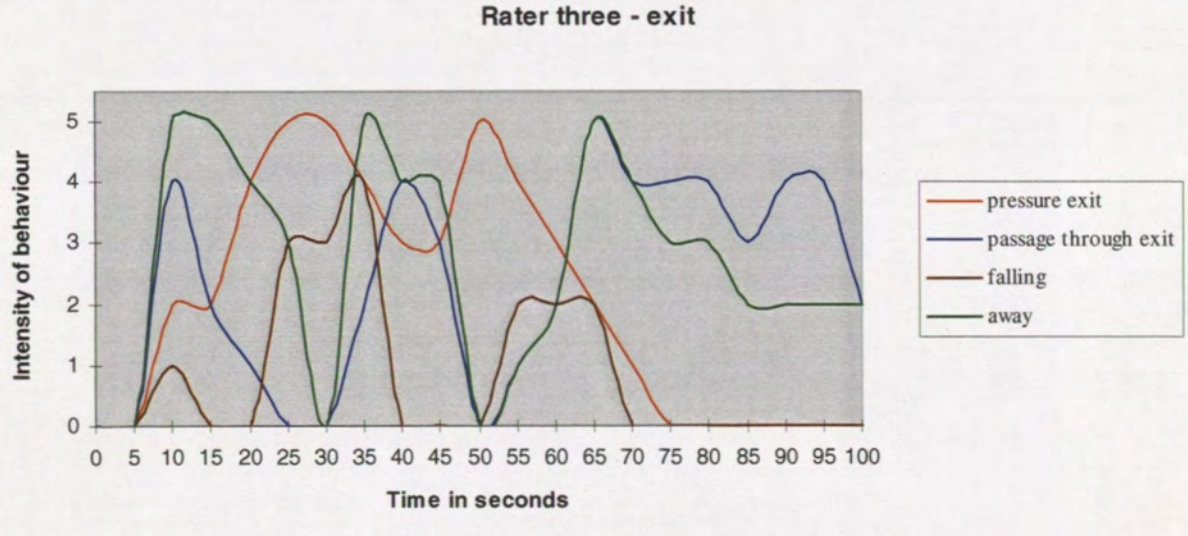
Rater three - cabin



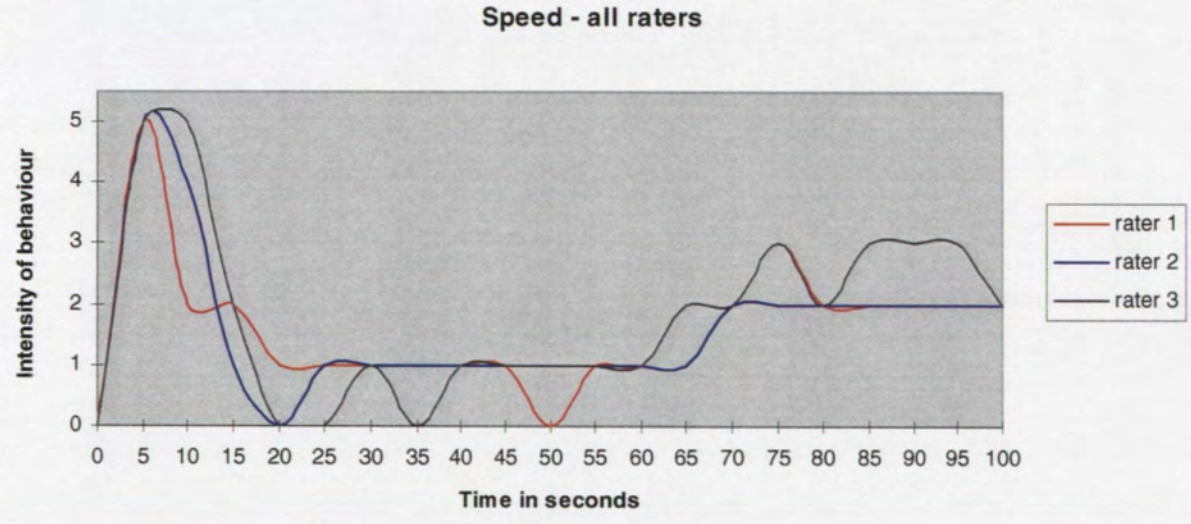
Competitive 50% - Type III exit

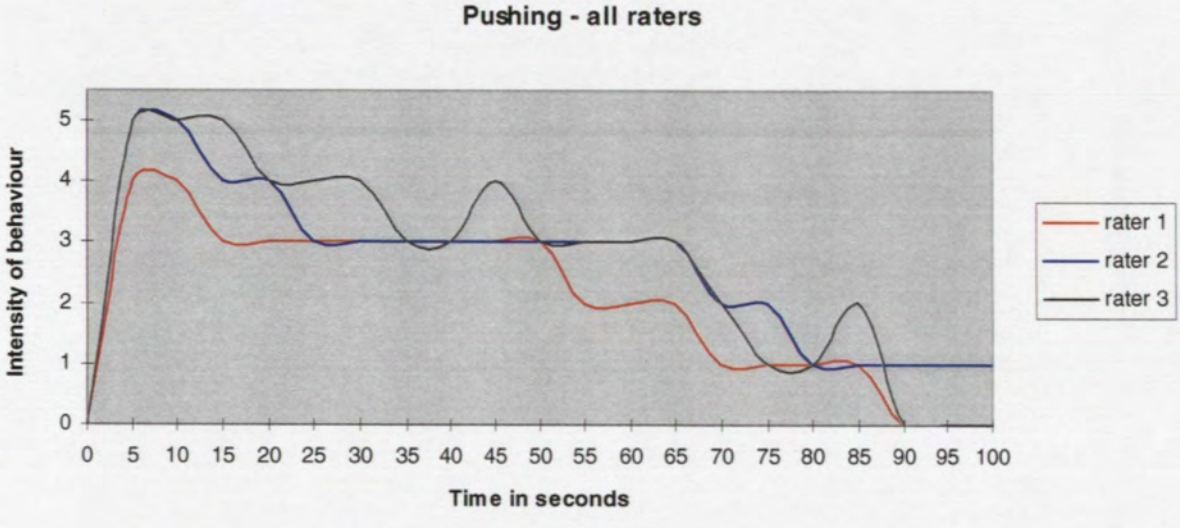


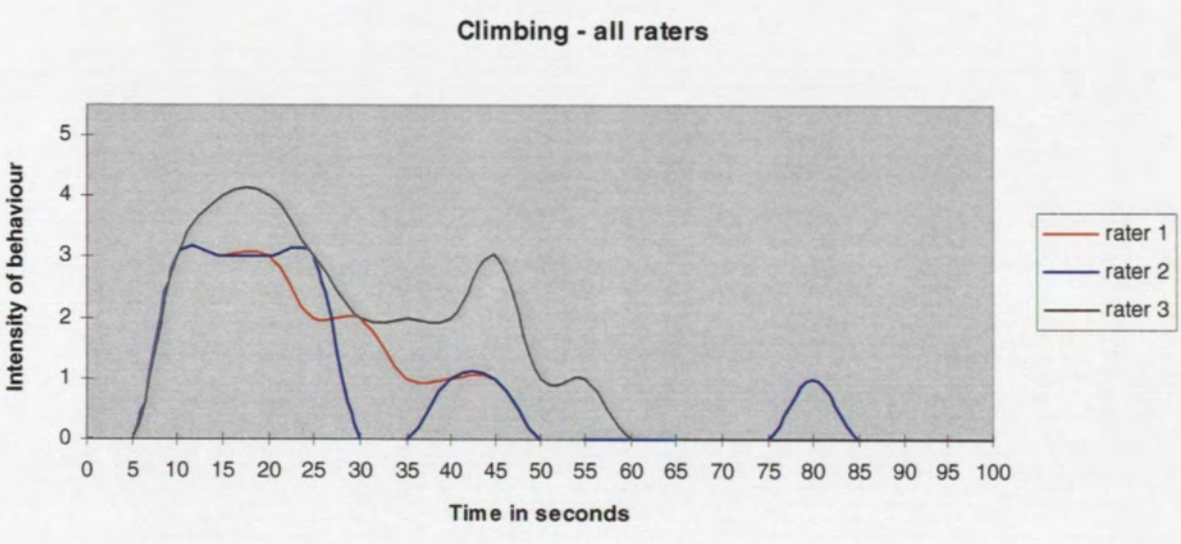




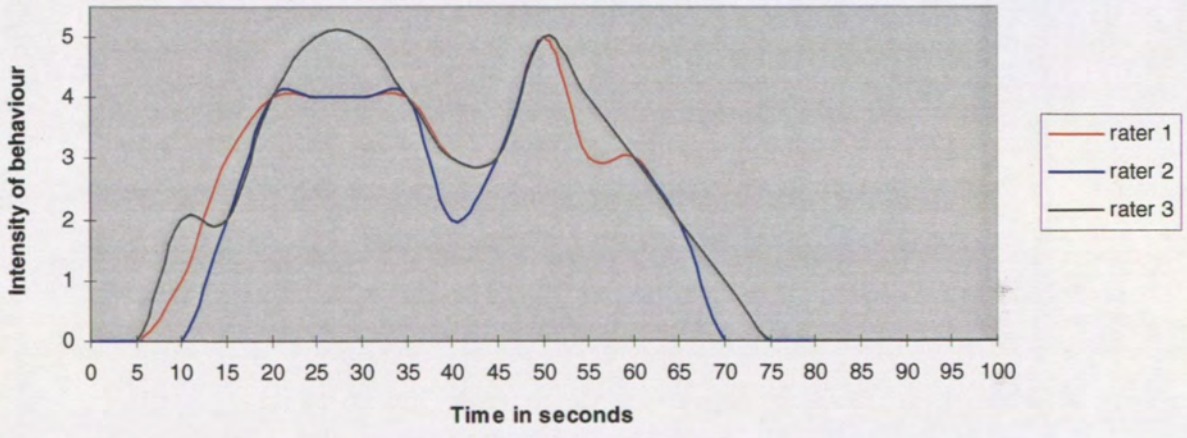
Competitive 50% - aggregate evacuation behaviours



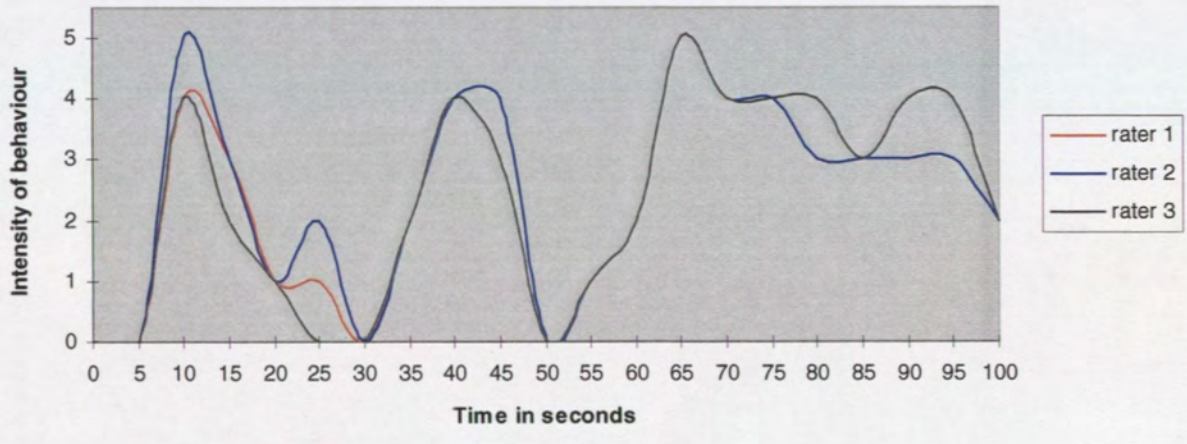




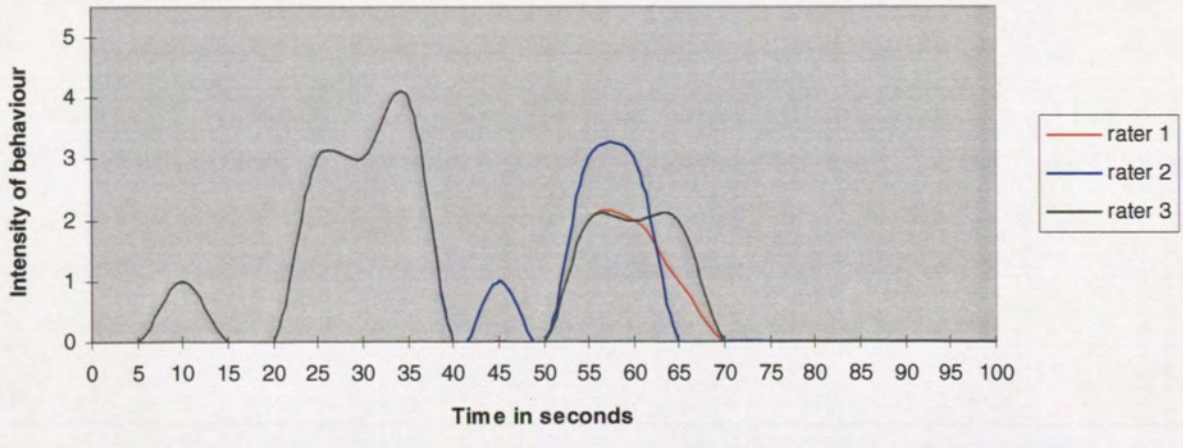
Pressure - all raters

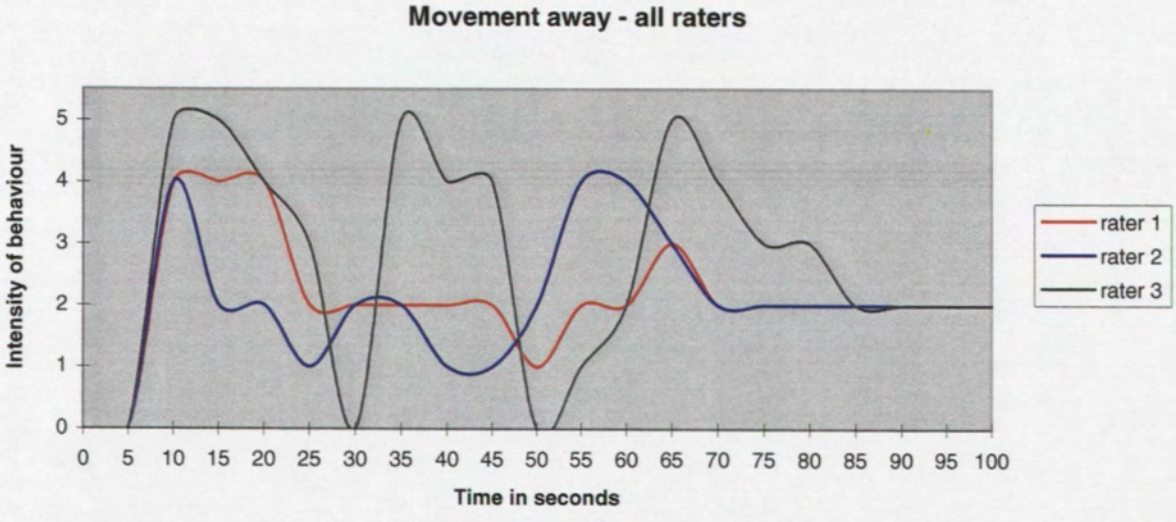


Speed of passage through exit - all raters



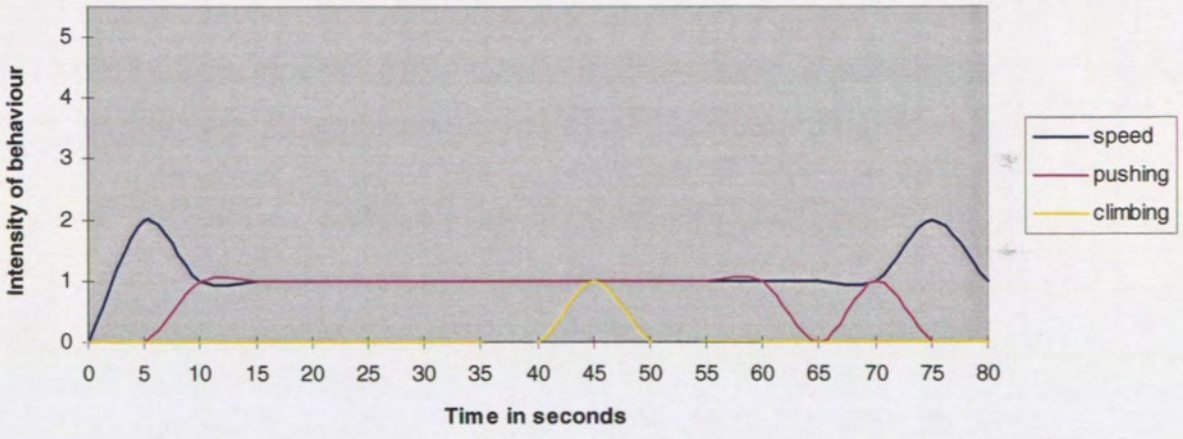
Falling - all raters



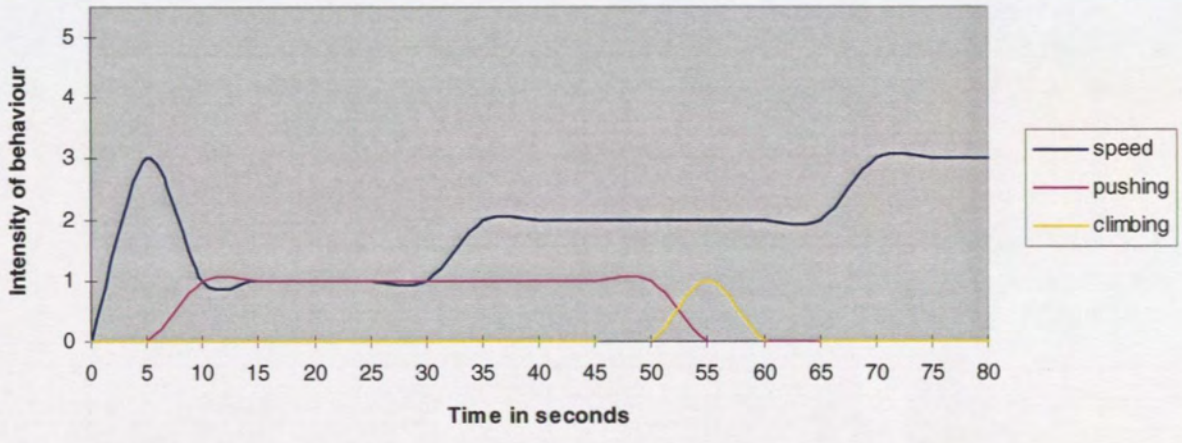

Movement away - all raters
Intensity of behaviour
0
1
2
3
4
5
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Time in seconds
rater 1
rater 2
rater 3

Co-operative – within cabin

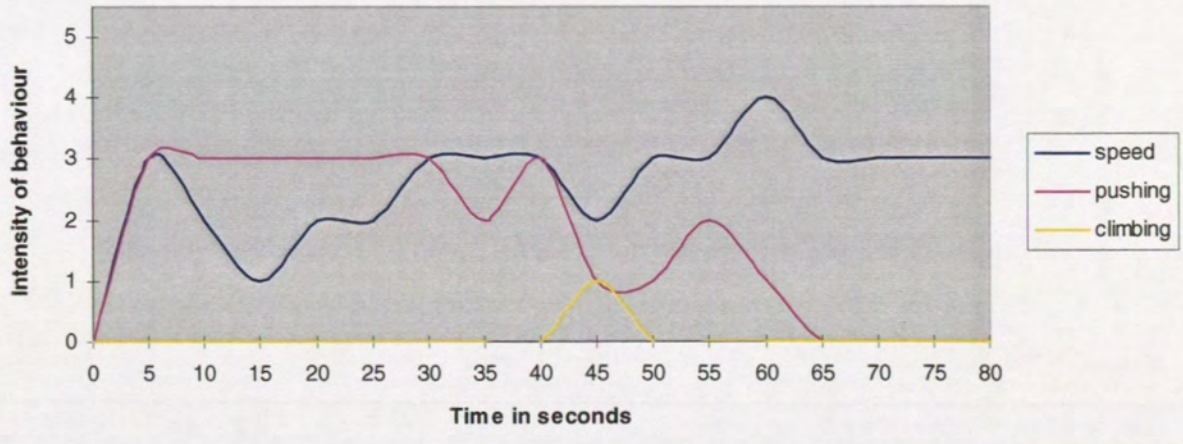
Rater one - cabin



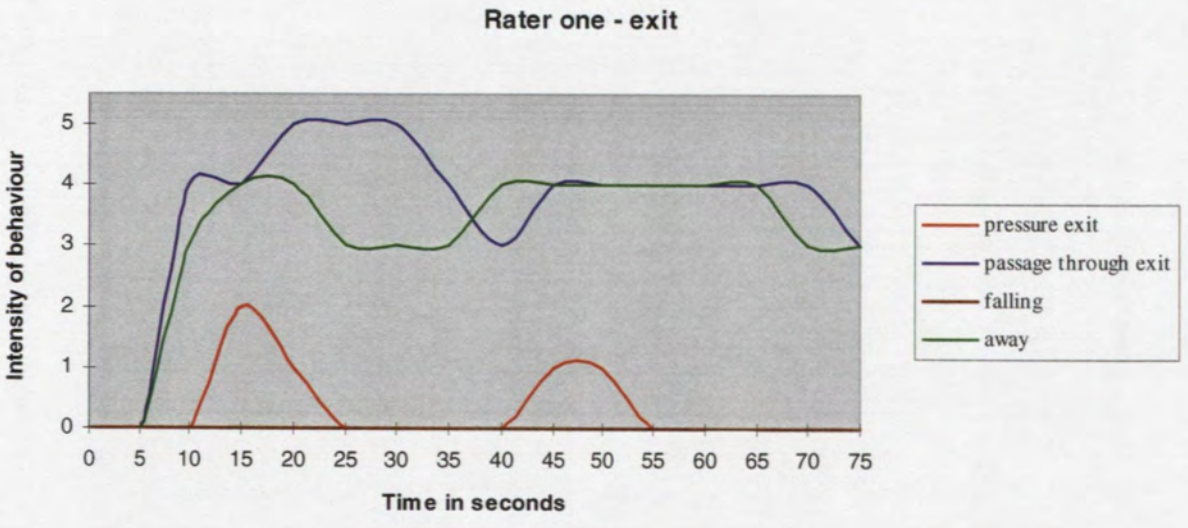
Rater two - cabin

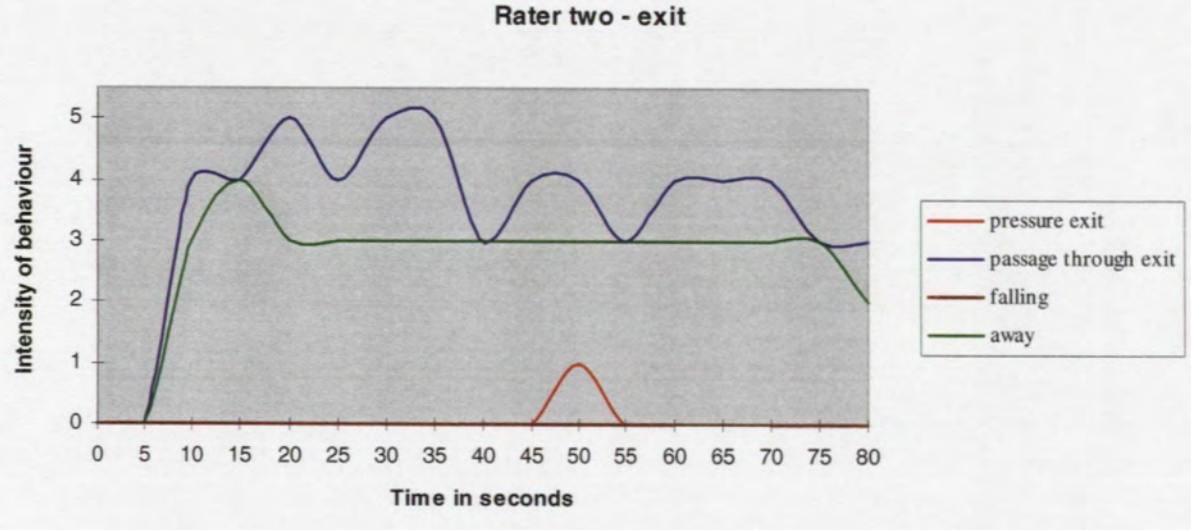


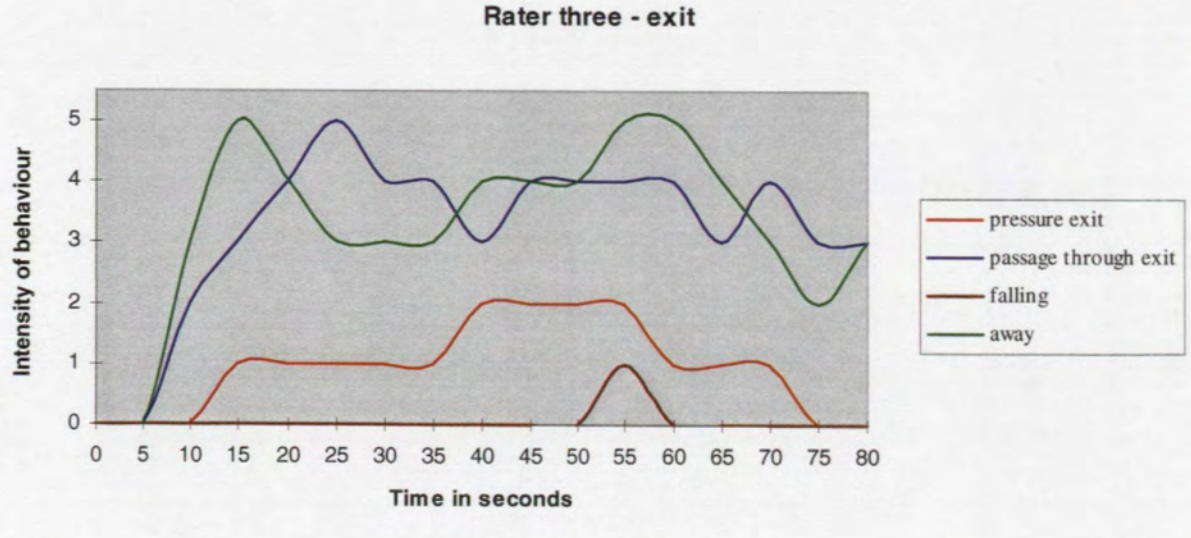
Rater three - cabin



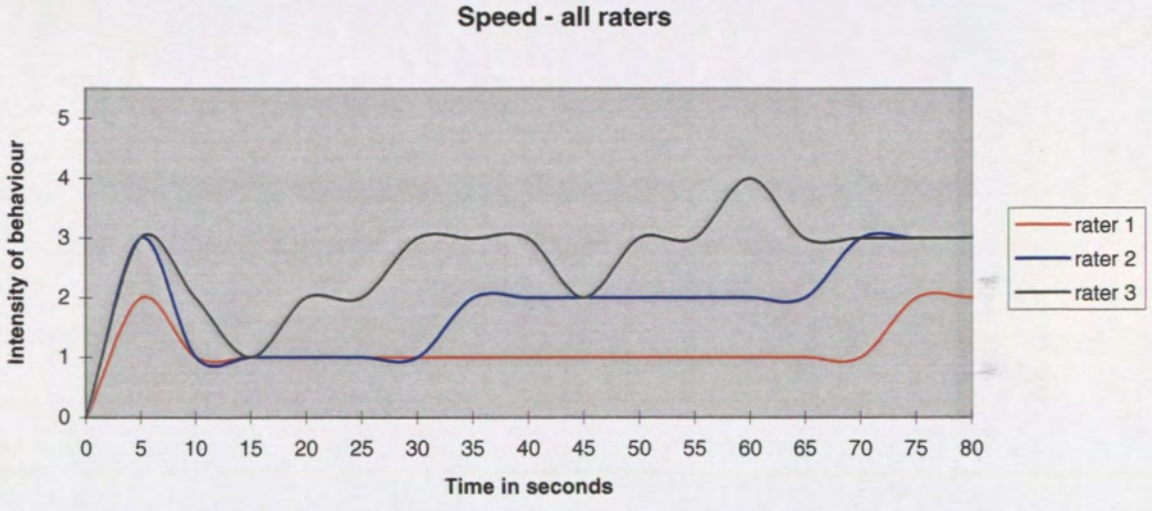
Co-operative – Type III exit

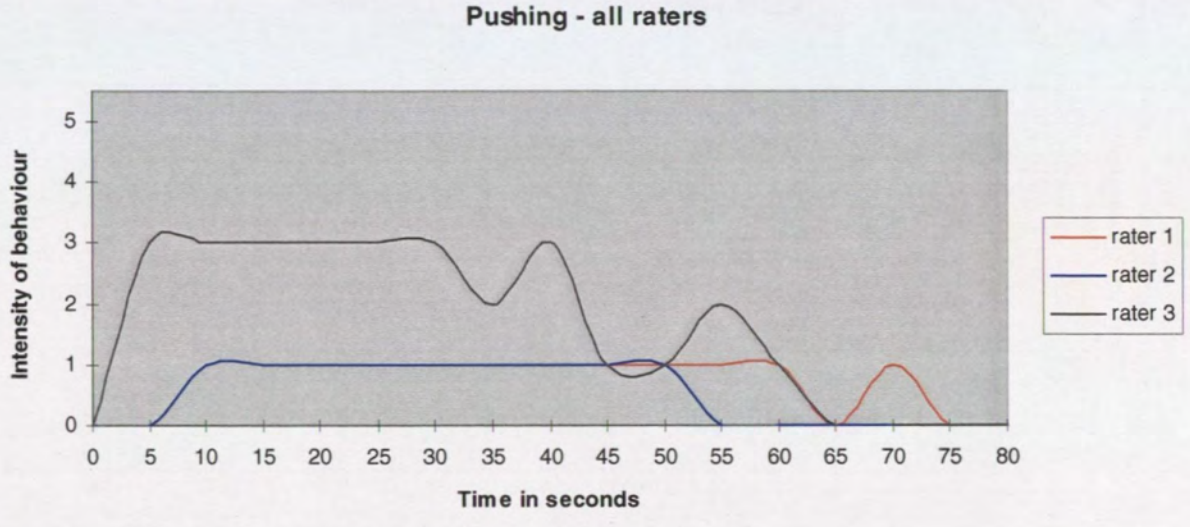


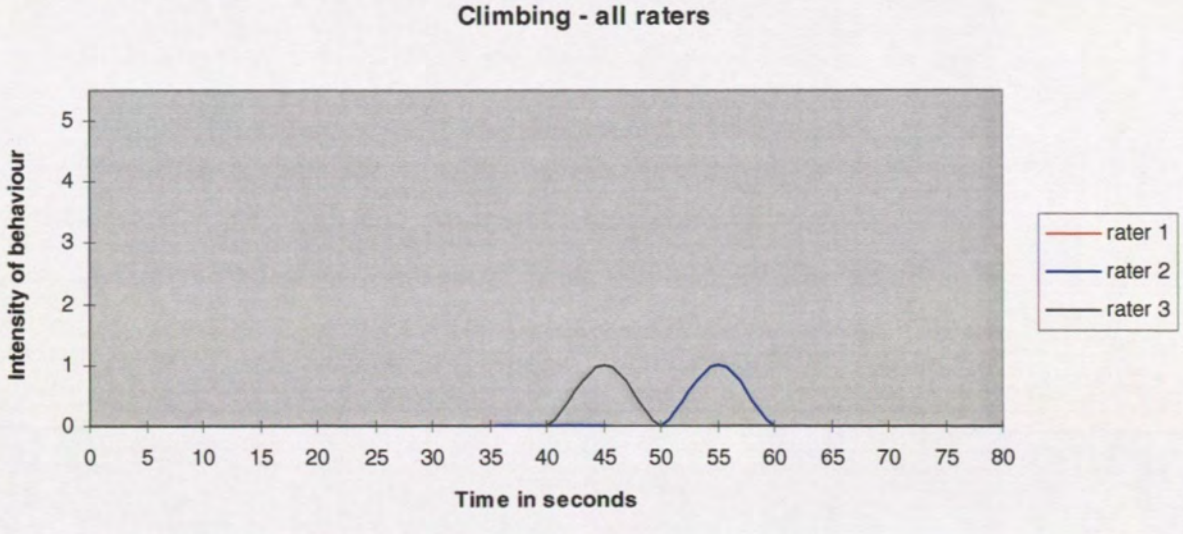




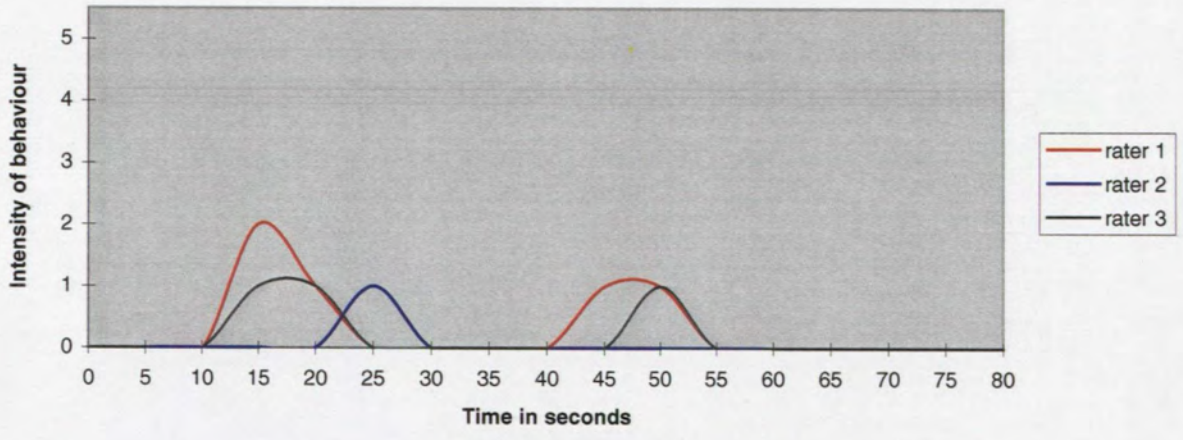
Co-operative – aggregate evacuation behaviours



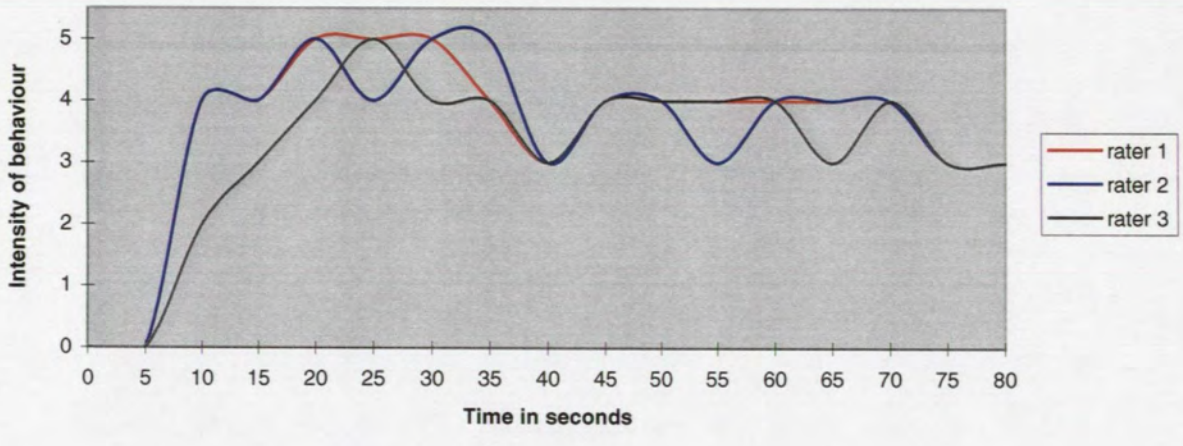




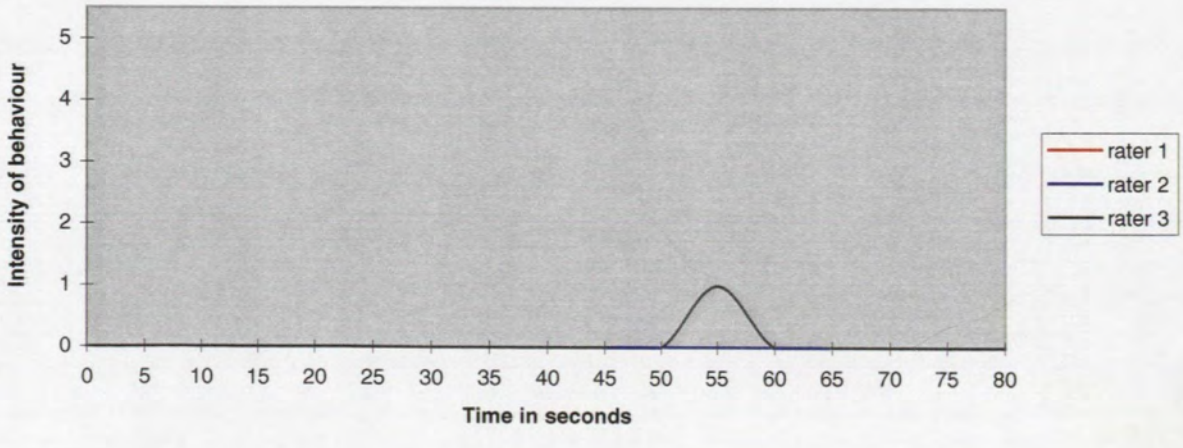
Pressure - all raters

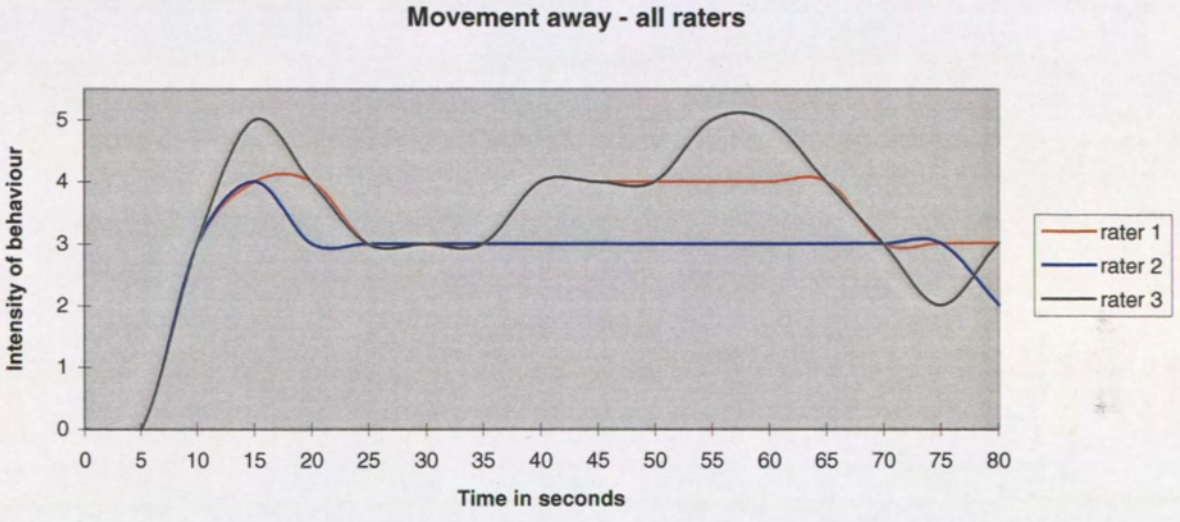


Speed of passage through exit - all raters



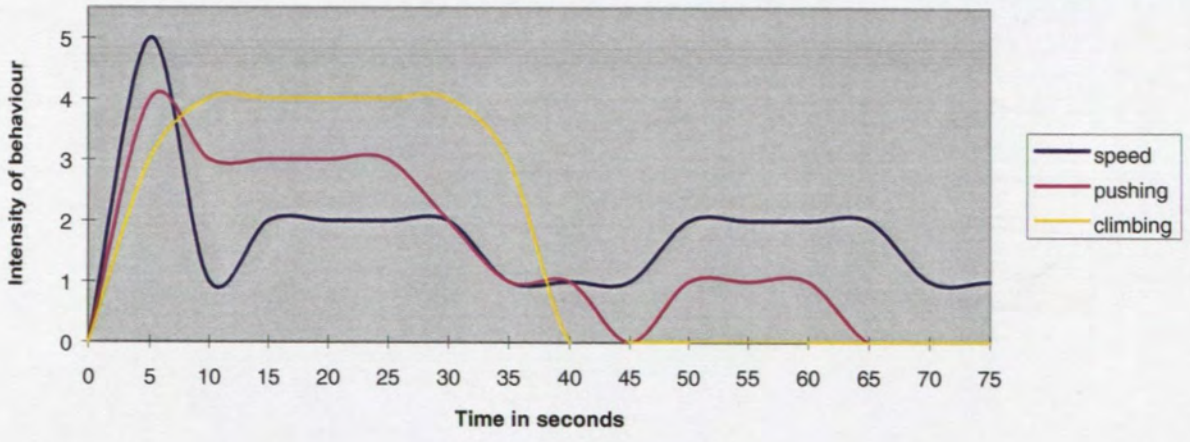
Falling - all raters



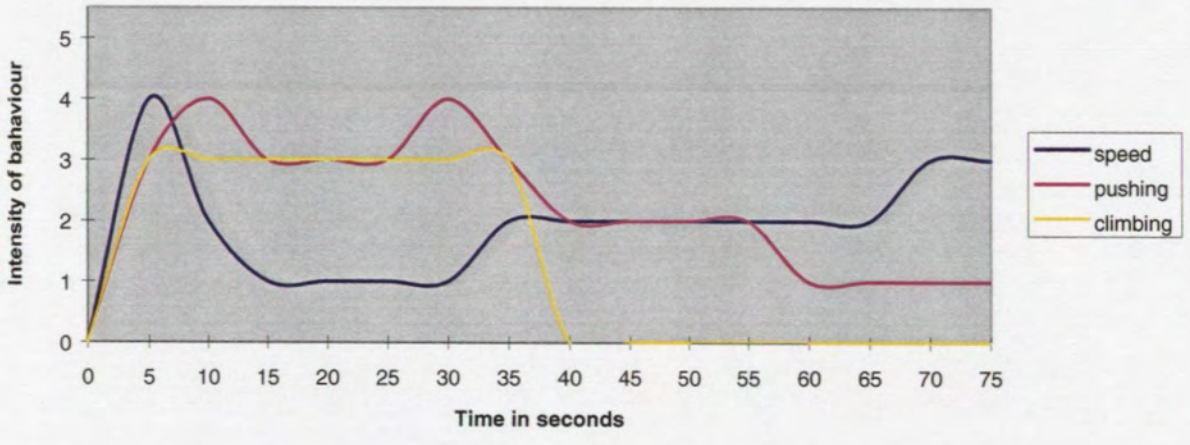

Movement away - all raters
Intensity of behaviour
0
1
2
3
4
5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Time in seconds
rater 1
rater 2
rater 3

25% delayed motivational payment - within cabin

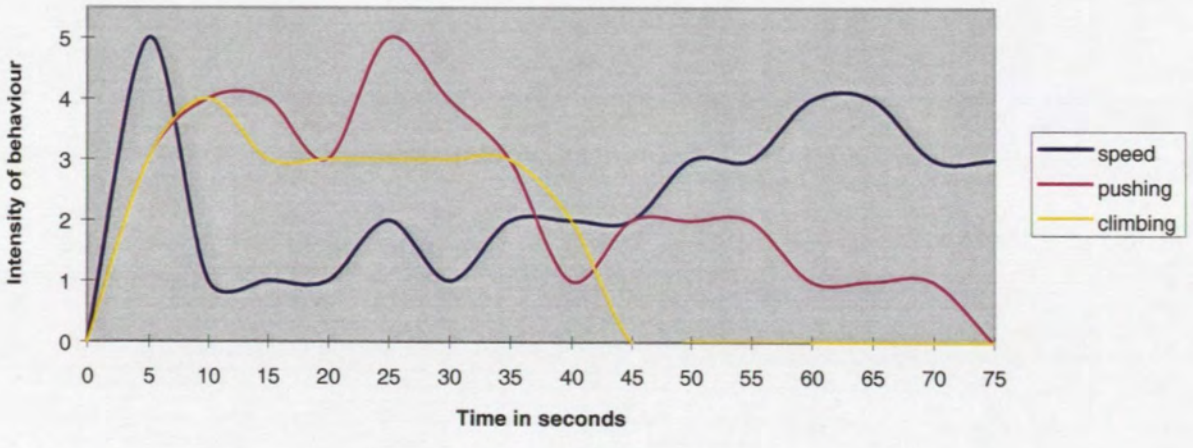
Rater one - cabin



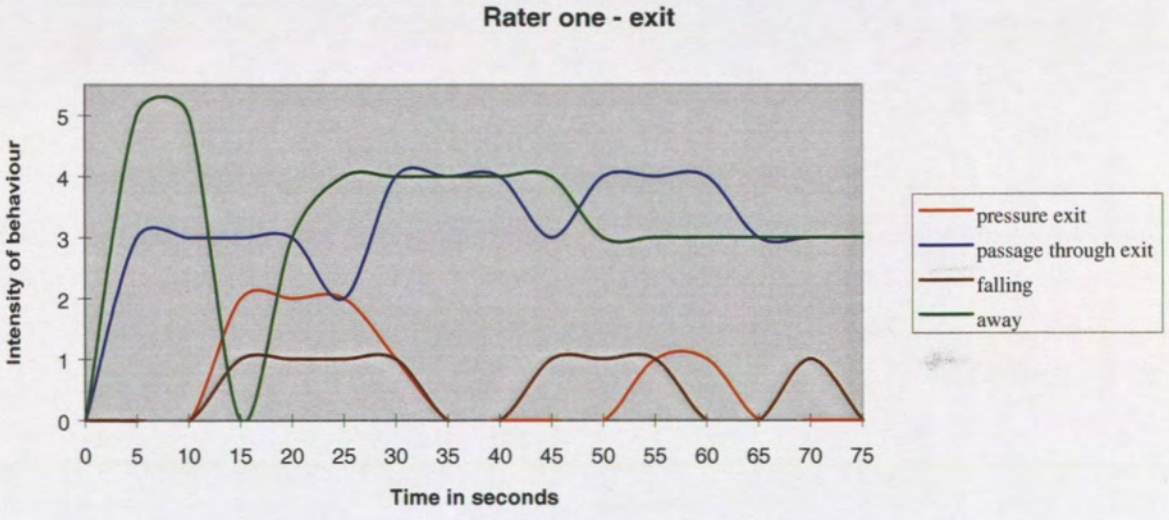
Rater two - cabin

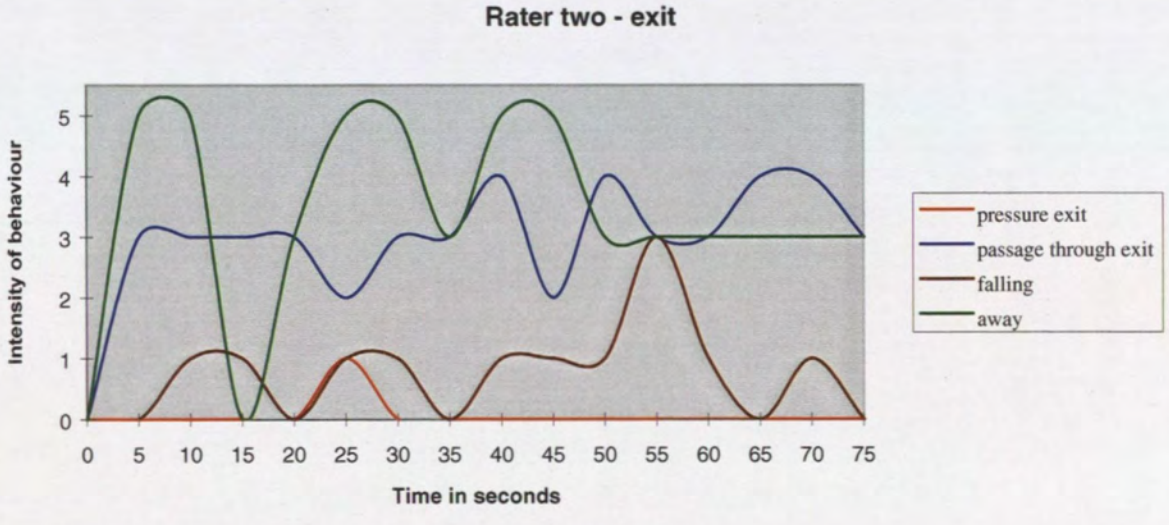


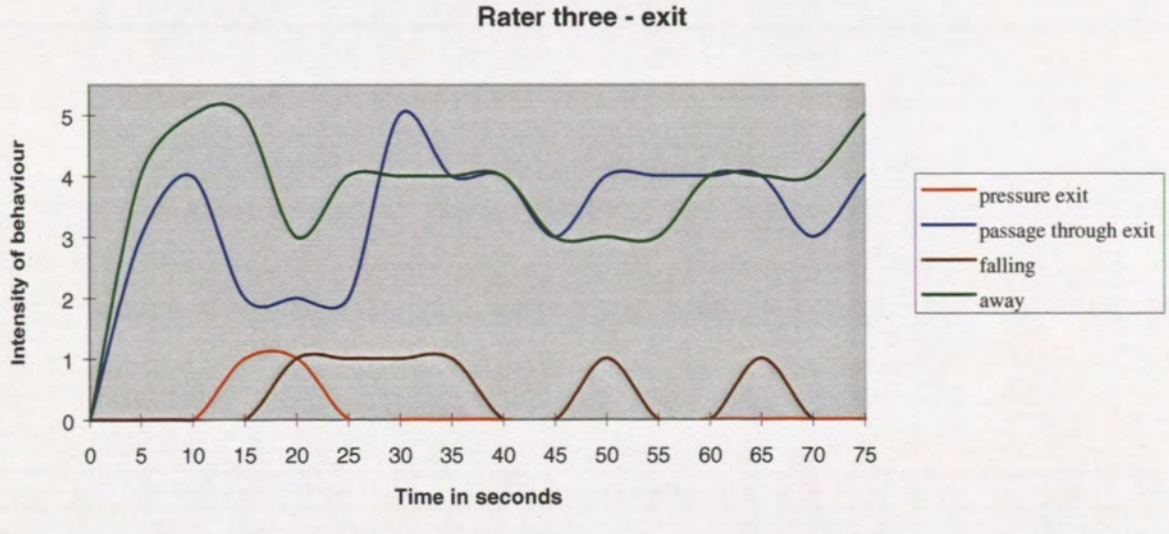
Rater three - cabin



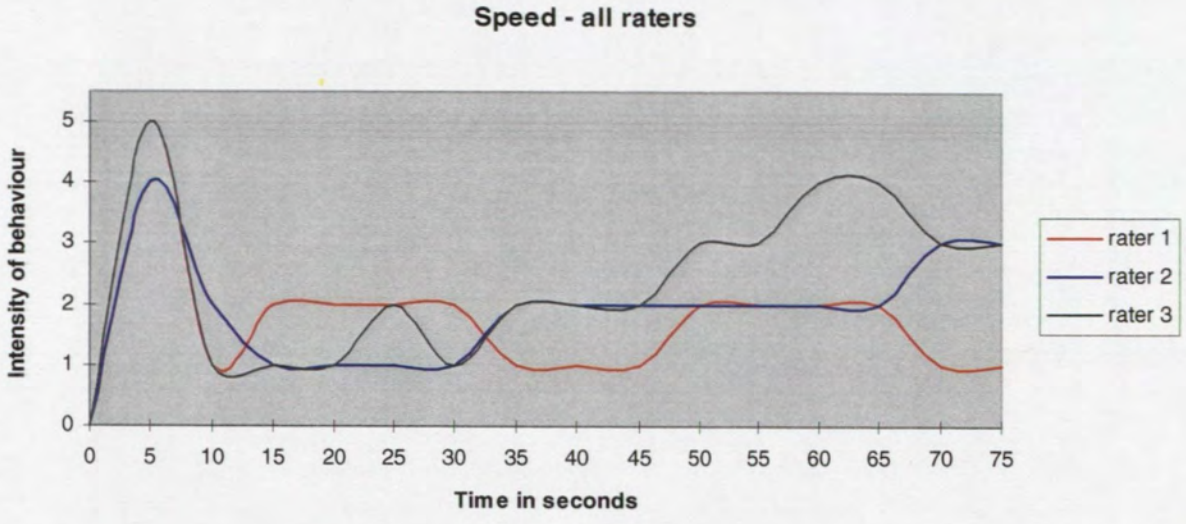
25% delayed motivational payment – Type III exit

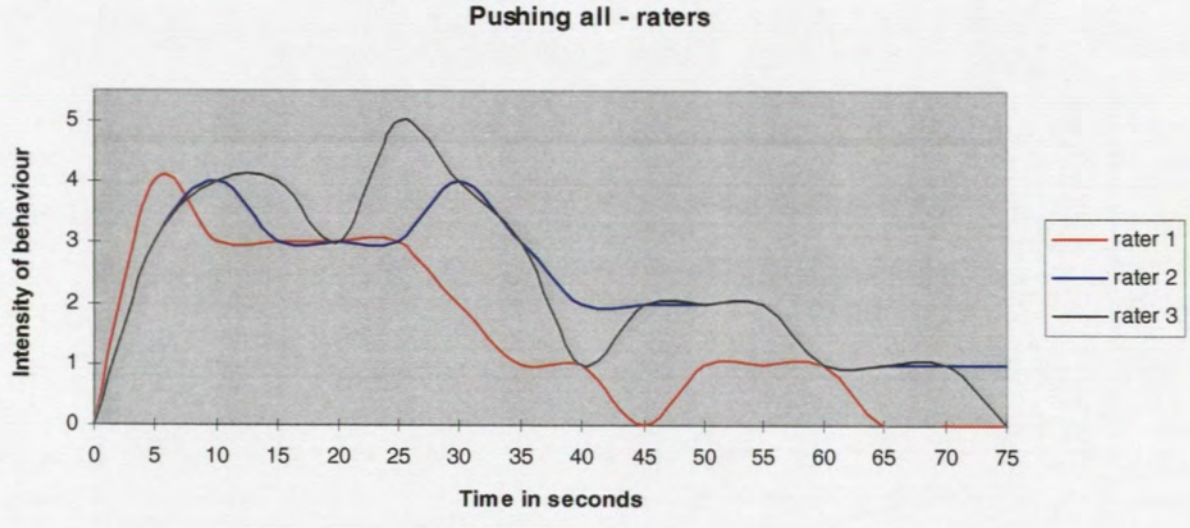


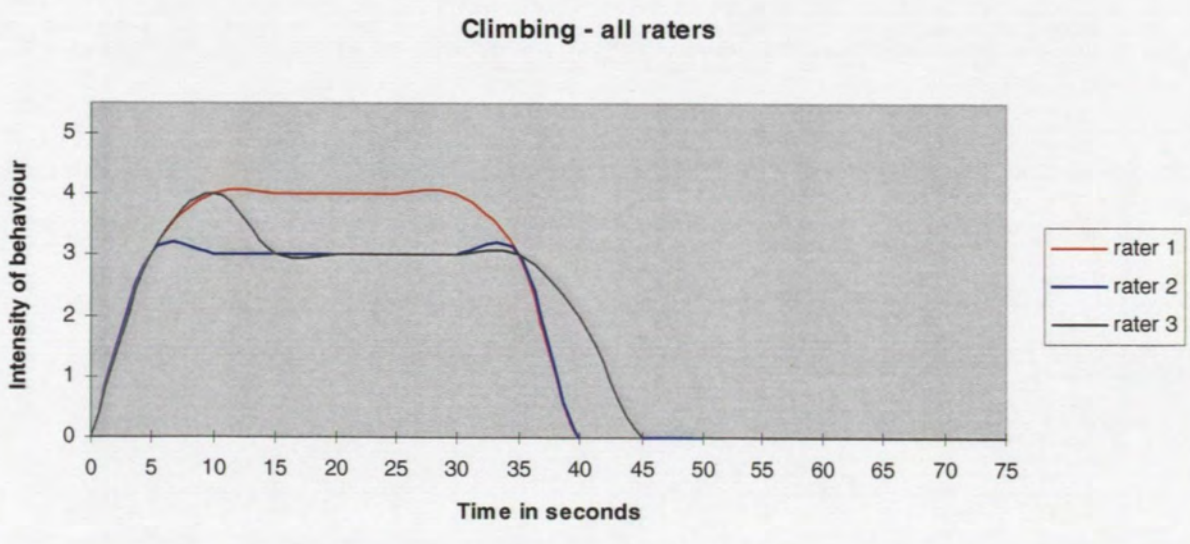




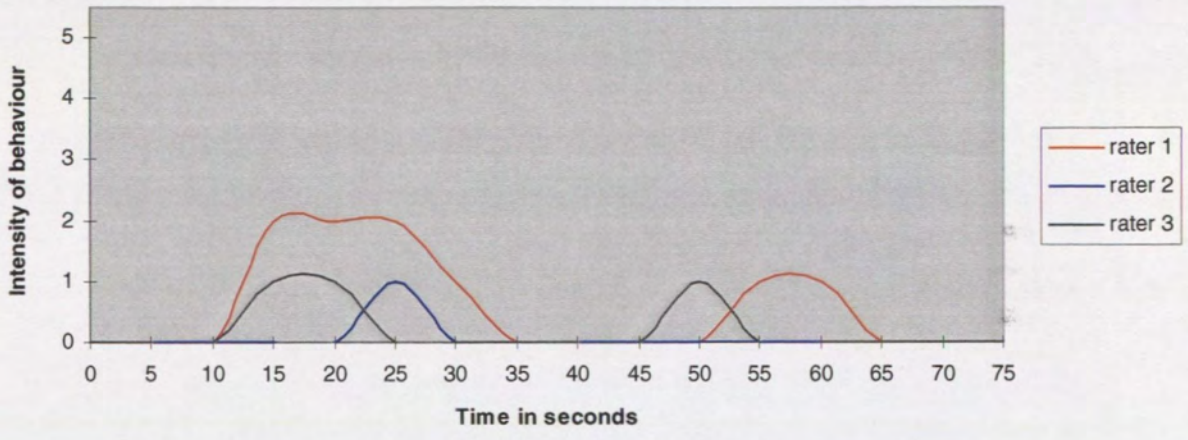
25% delayed motivational payment - aggregate evacuation behaviours



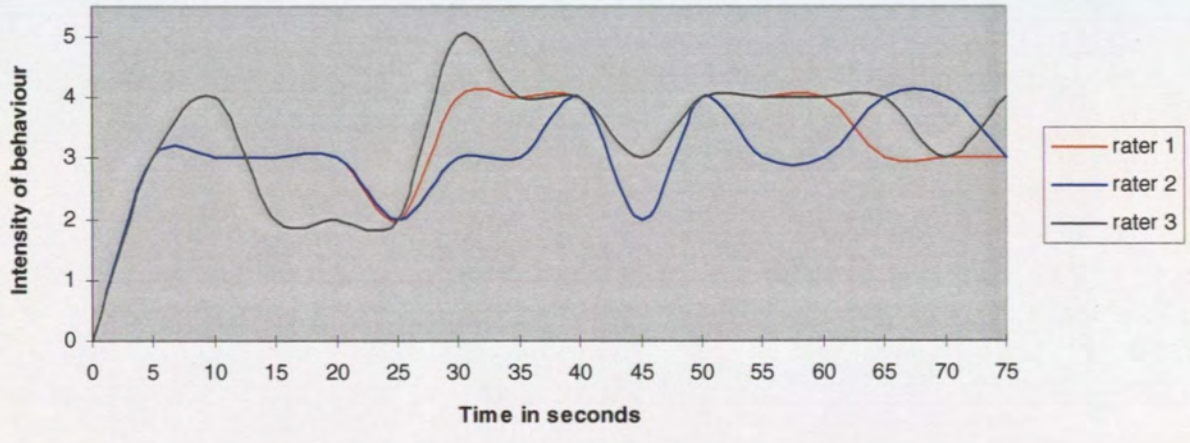




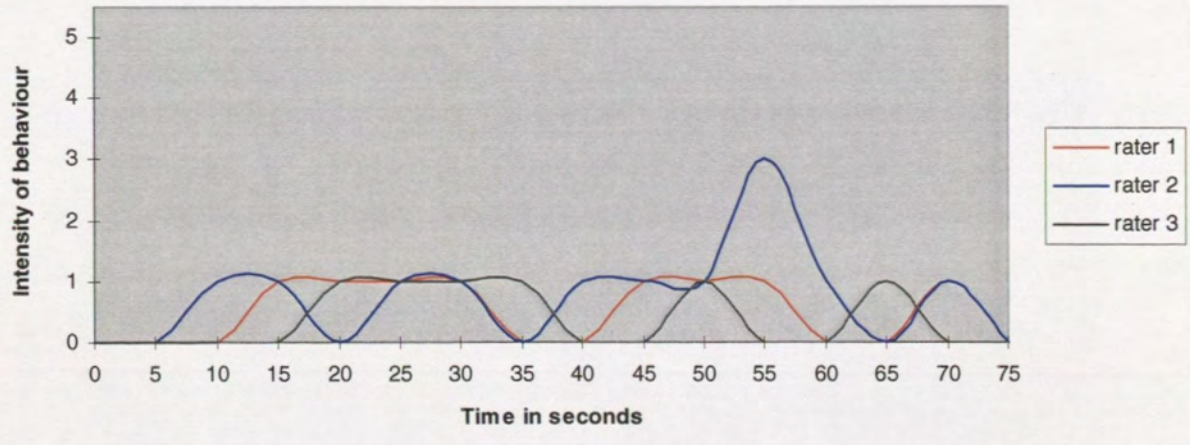
Pressure - all raters

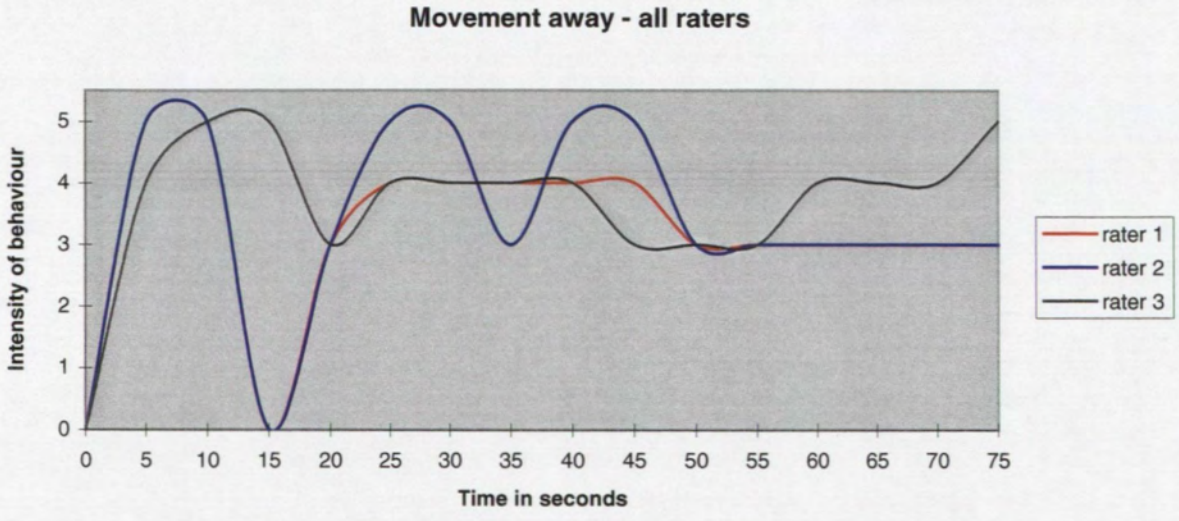


Speed of passage through exit - all raters

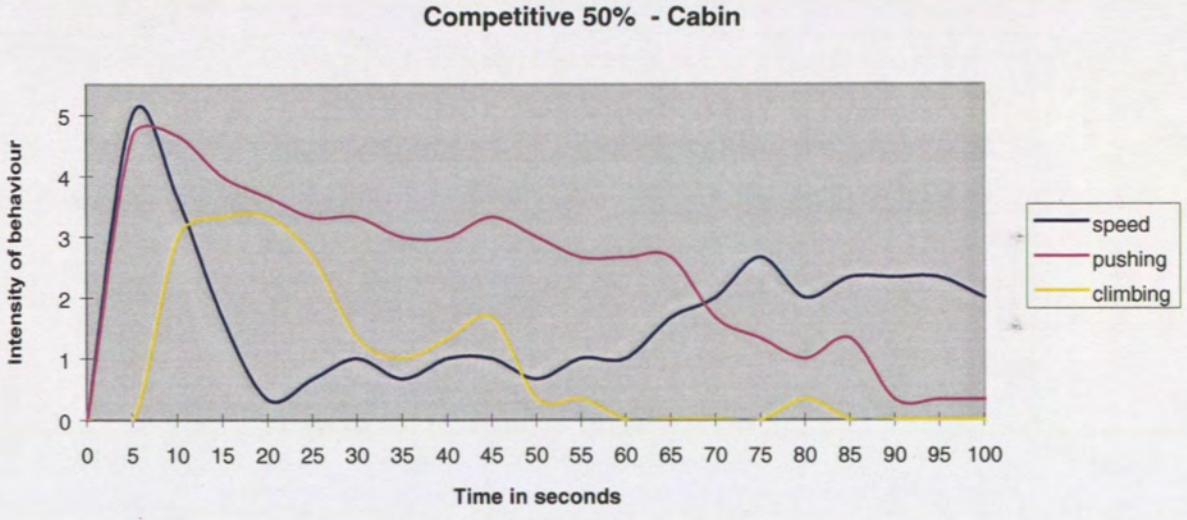


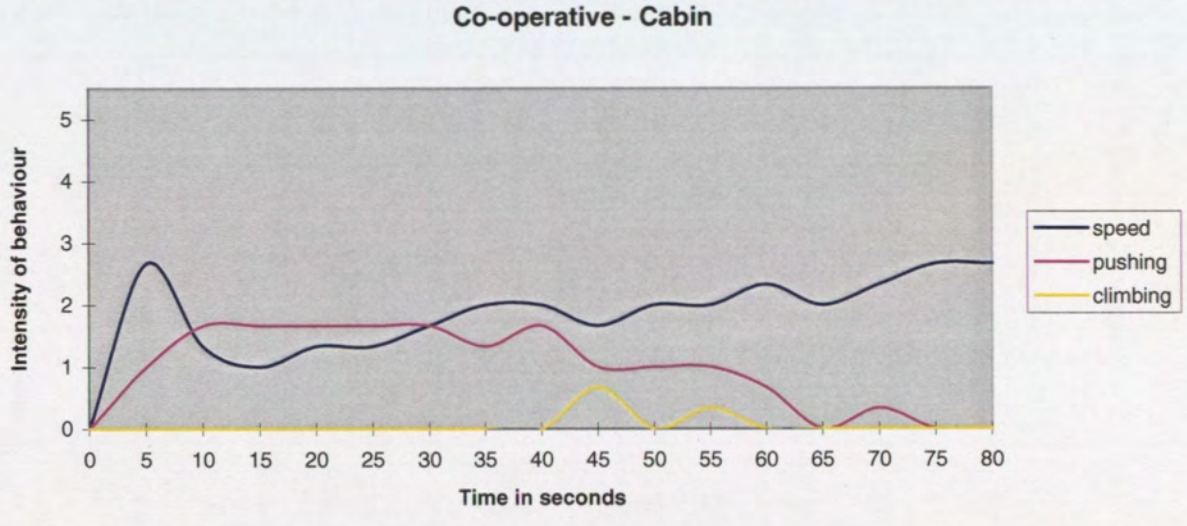
Falling - all raters

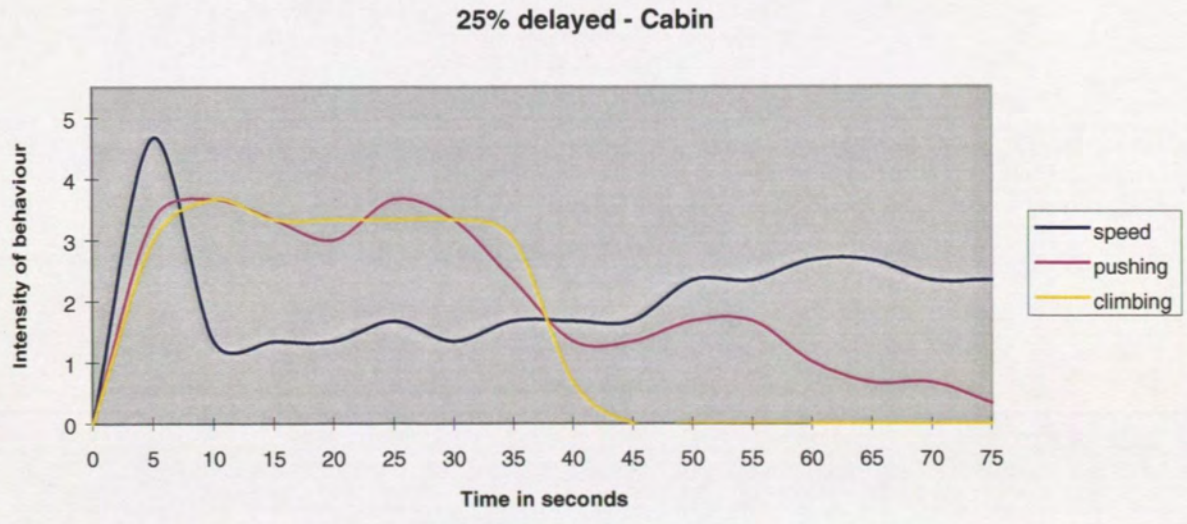



Movement away - all raters
Intensity of behaviour
0
1
2
3
4
5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Time in seconds
rater 1
rater 2
rater 3

Average ratings – within cabin

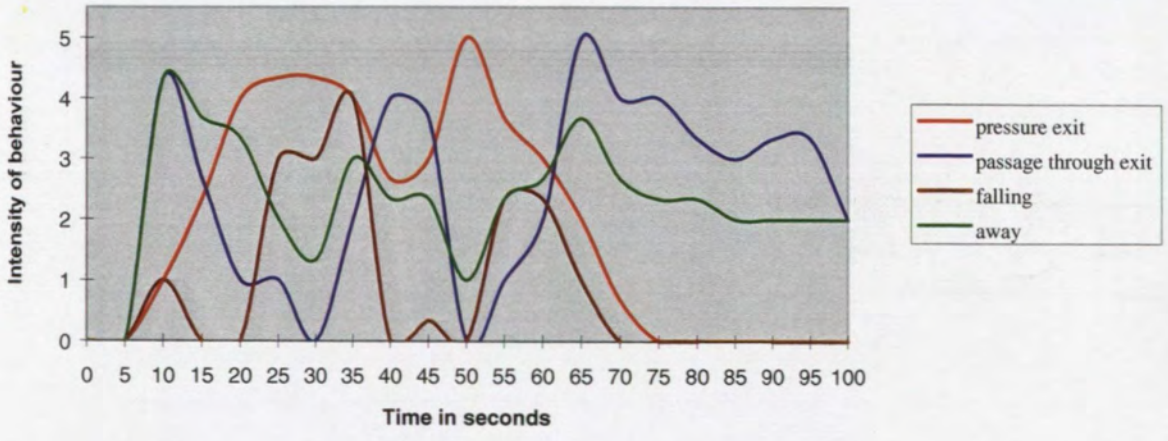




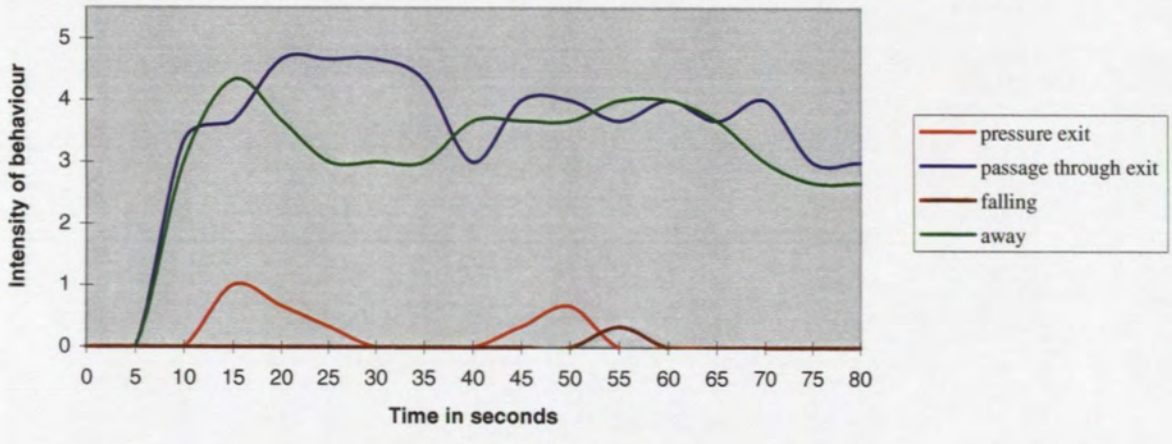


Average ratings – Type III exit

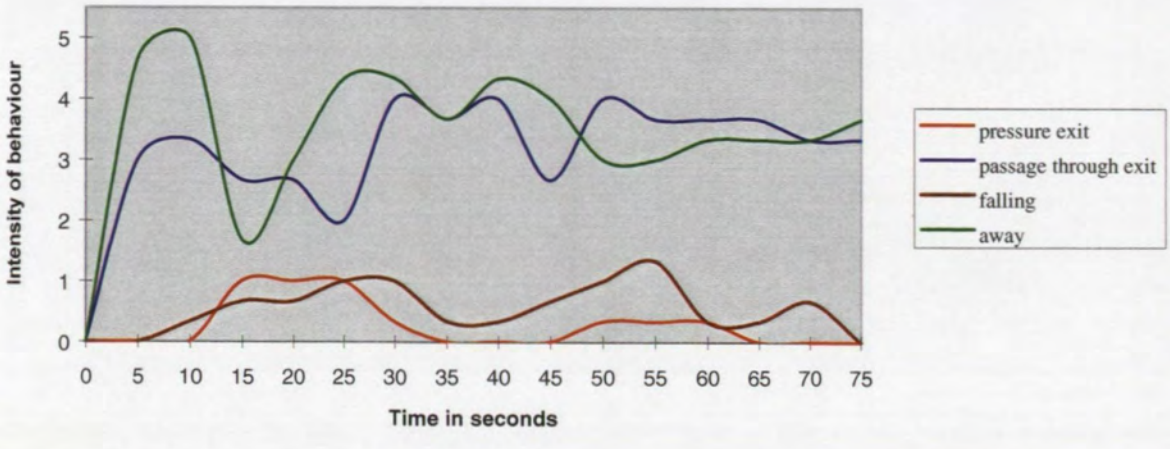
Competitive 50% - Exit



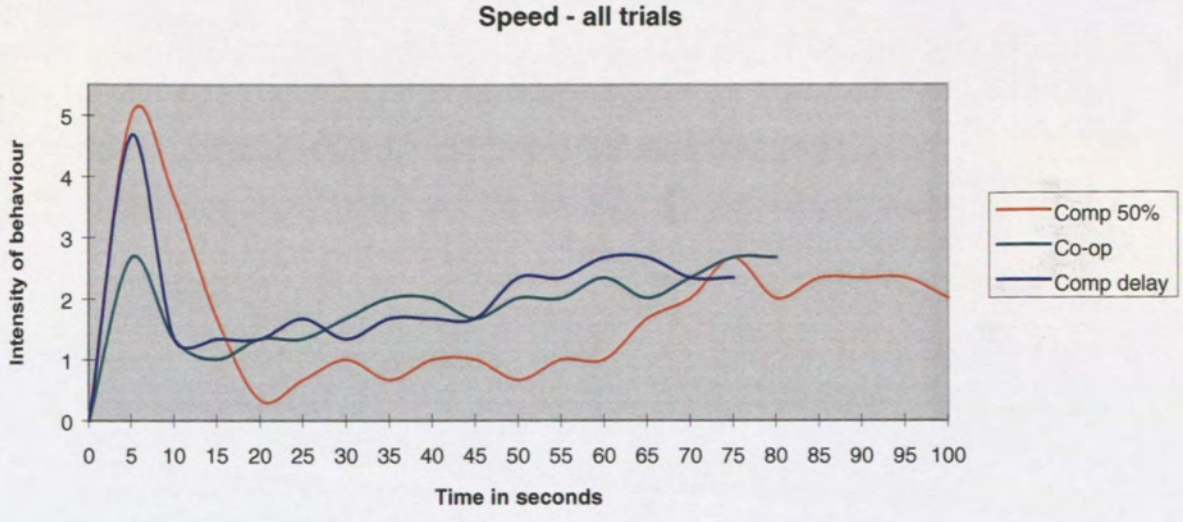
Co-operative - Exit

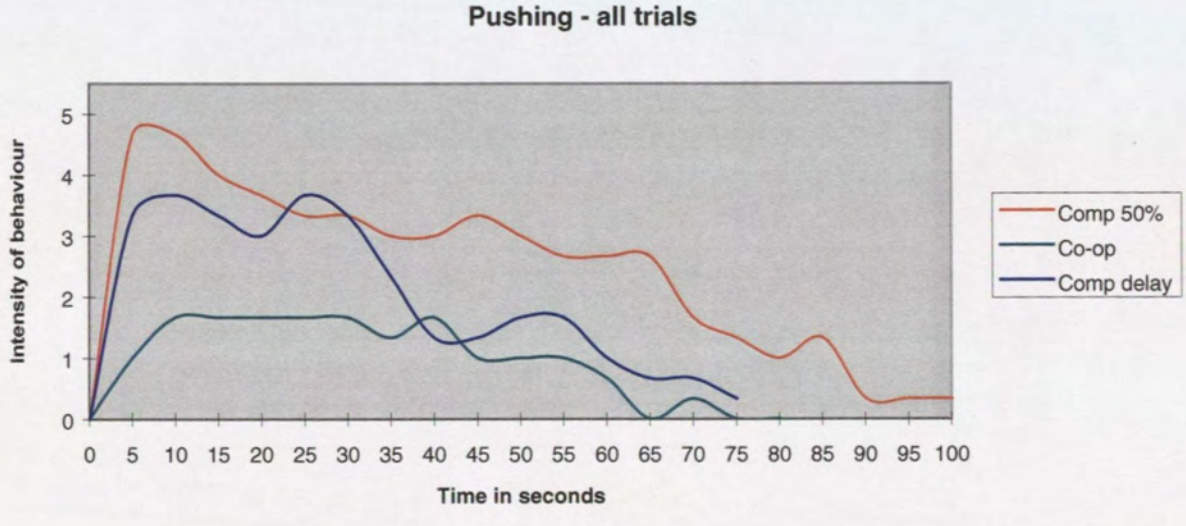


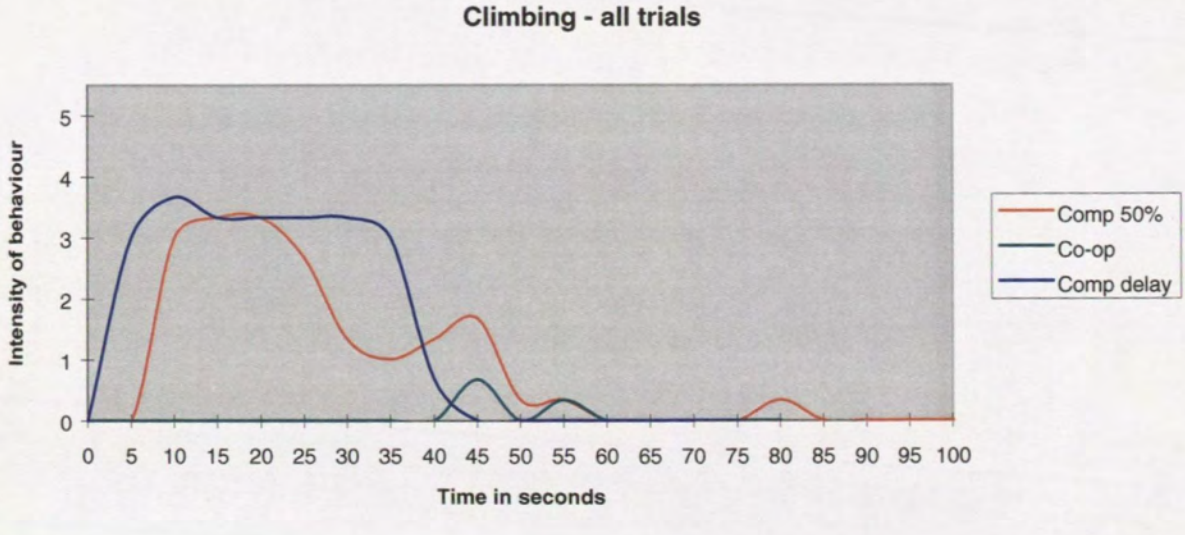
25% delayed - Exit



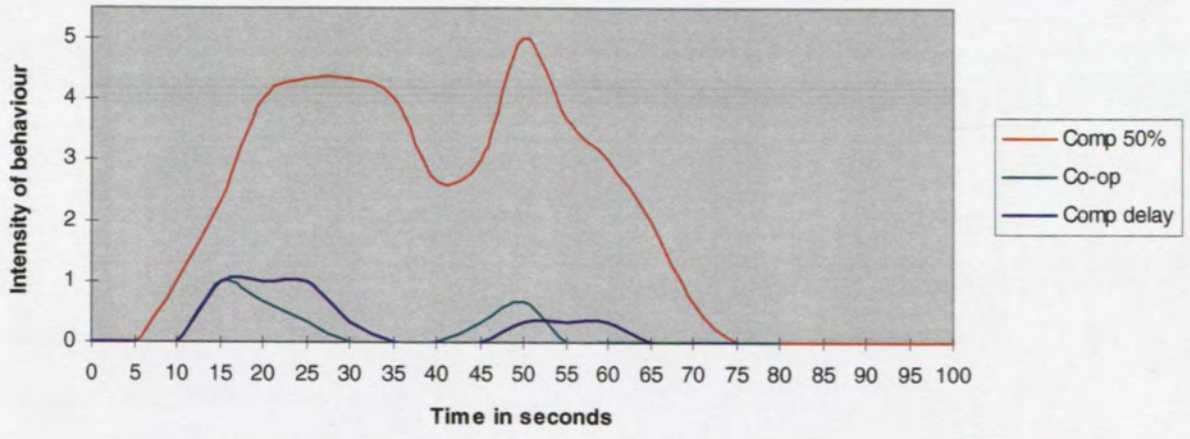
Average ratings - aggregate evacuation behaviours



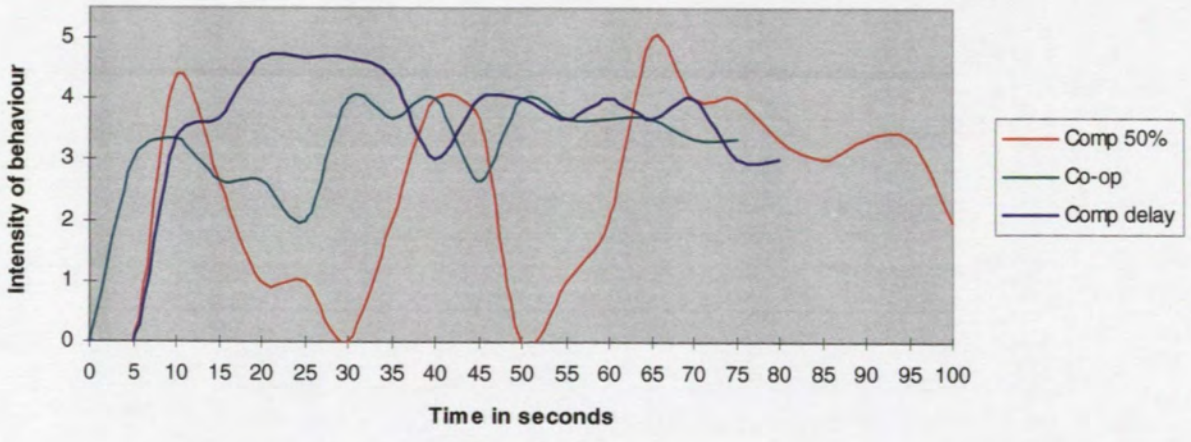




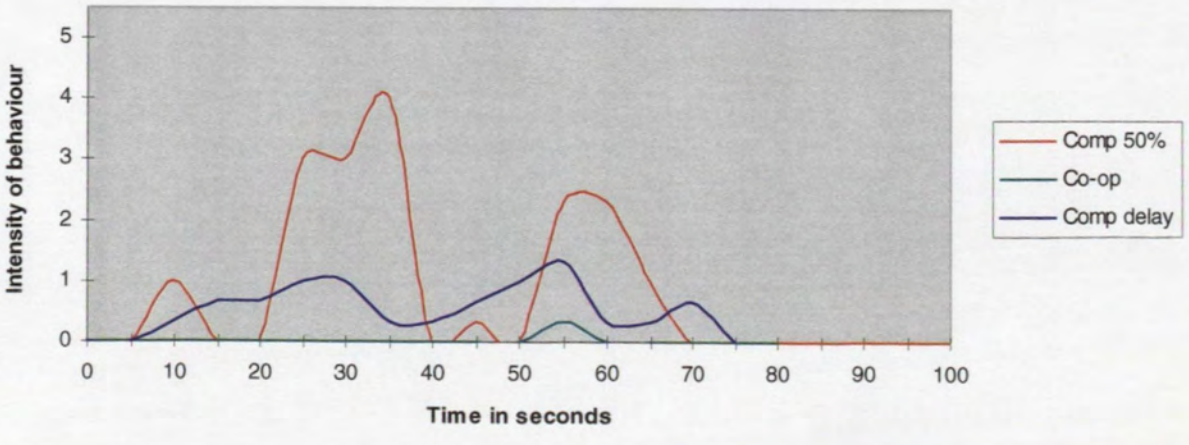
Exit Pressure - all trials

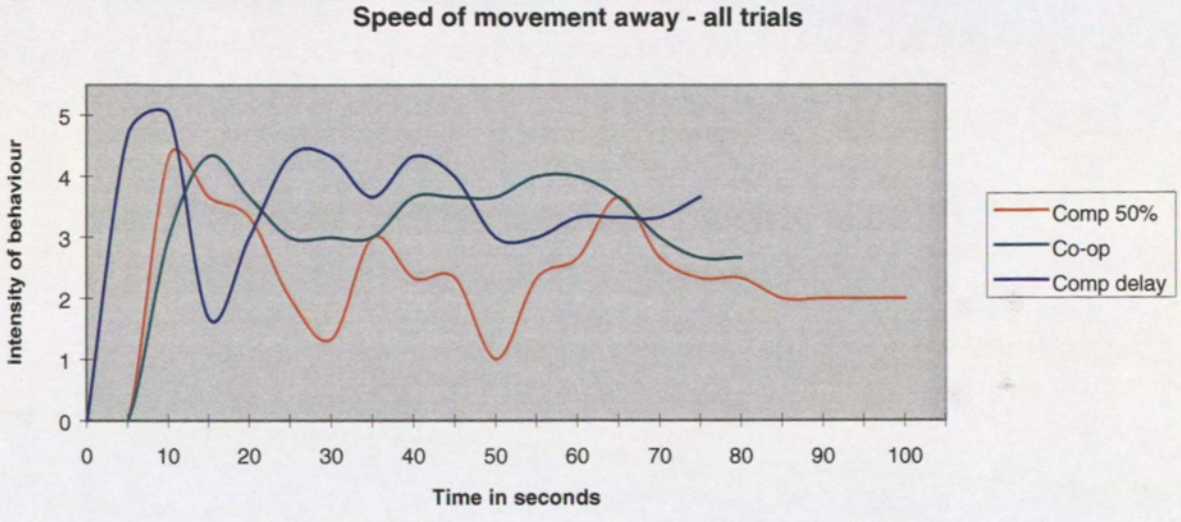


Passage through exit - all trials



Falling - all trials




Speed of movement away - all trials
Intensity of behaviour
0
1
2
3
4
5
0
10
20
30
40
50
60
70
80
90
100
Time in seconds
Comp 50%
Co-op
Comp delay