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Comics as a Cognitive Training Medium for Expert Decision Making

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COMICS AS A COGNITIVE TRAINING MEDIUM

FOR EXPERT DECISION MAKING

by

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ABSTRACT

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Experts such as military commanders must make decisions quickly and under deadly conditions A variety of cognitive training media exist, from Powerpoint to virtual reality (VR) simulations, however, there are alternative media that have not yet been comprehensively studied for expert decision making training In this study, the researcher has examined the use of comics as an alternative to current cognitive training media In Experiment 1, naval submariners were shown a text-based medium or comic strip and asked to make a decision about the scenario after viewing The scenario was derived from a situation that submariners were somewhat familiar with but could not predict In Experiment 2, the level of comic symbolic abstraction was manipulated across three separate comic strips Results showed that submariners' decision making ability scores were not superior and response times were not faster with comic media than text-based media Results also did not show superior scores with lower levels of symbolic abstraction View time for comics was significantly faster than text-based media for Experiment 1 Several post-hoc results for decision making ability scores and response times were also significant

Post-hoc results showed that submariners' decision making ability scores between comic media and text-based media for Experiment 1 were equivalent at the 90% confidence intervals and were equivalent at the 95% confidence intervals for Experiment

2 Speed was equivalent at the 98% confidence intervals for both Experiment 1 and 2 View time was also equivalent at the 98% confidence intervals for Experiment 2 Comics have shown to be an alternative to current cognitive training media The findings show that comics have the potential to meet the needs of the diverse military population for rapid and comprehensive soldier training

My father, Michael Nalu, was an architect – technically driven and creative My mother, Frances Nalu, is a scientist – biologist and researcher Both inspire me to reach the highest potential in my life I've chosen to reach my highest potential in the most creative, technical, scientific realm – human factors

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Training can be used for many purposes – to inform new members of a workforce about workplace policies and procedures, to teach specific skills, or to improve mastery of a particular task Depending on the job or task, various training media may be used to educate naive learners These media range from traditional text-based tools, such as books or manuals, to high fidelity virtual reality (VR) simulations Effective training requires a medium that will efficiently prepare trainees to accurately make a decision, carry out a task, or understand a concept

Training is important to members of the military because it helps them prepare for dangerous tasks such as combat The military defines training as, "a system of techniques and standards that allows Soldiers and units to determine, acquire, and practice necessary skills," (Department of the Army, 2008, p 1-5) Soldiers must be trained to make decisions quickly and accurately, in fact, the complex, risky situation of battle requires precise decision making for survival Accordingly, the proper training medium for expert decision making in the military should provide a means for communicating dangerous aspects of real-world conflict situations using demonstrations or instruction

Military decision making is often complex, ambiguous, and potentially dangerous Traditional decision making theories, such as Subjective Expected Utility (SEU) Theory, are based on alternative decision making (Wright, 1984) Alternative decision making results in the choice of a single solution from many possibilities However, in complex situations, expert decision making often does not yield a single correct solution

Therefore, traditional decision theories are often overly simplistic for such situations Current models, stemming from such frameworks as Naturalistic Decision Making (NDM) (Klein, 2008), allow for greater flexibility, and are therefore more relevant for decision making in complex, dangerous circumstances Therefore, they are frequently applied to military tasks (Ross, Klein, Thunholm, Schmitt & Baxter, 2004)

Everyone, including expert military commanders, makes decisions by selecting essential information from the environment and mentally processing that information (Wickens, 2002) Military commanders must accurately select pertinent information from complex situations while under time constraints and battle stress They must then combine that information into an understandable awareness of the battle situation After the concept is formed, commanders must relate it to their knowledge base, and further weigh the benefits of several options Only then can decisions be executed Cognitive training allows for this learning process to occur more quickly and without harmful repercussions

Cognitive training helps novice decision makers isolate pieces of information that are most important without completing years of experience in the field Experts often learn to recognize such critical cues through experience (Klein, 2008) By understanding how experts produce accurate critical decisions under conditions of uncertainty, it may be possible to train others to do the same

The purpose of Foshay, Silber, and Stelnicki's (2003) Cognitive Training Model is to help trainers design pedagogical materials According to that model, communication from the training medium to the trainee should be intuitive and easily understandable The material being learned through the training medium should also reflect guidelines to

ensure that trainees reach their learning goals The appropriate medium for training decision making skills is subject to debate because of several theoretical and practical limitations (Foshay et al , 2003) Theoretical limitations include achieving expert-level problem solving performance, handling highly complex scenarios that offer several correct solutions, and deriving strategies for volatile situations (Foshay et al , 2003) Practical limitations include higher costs due to longer training sessions, greater overall training time required, and more time required for training development

Cognitive training is a way of adding information to a trainee's existing knowledge in a way that supports ultimate training goals such as expert decision making In military situations, accomplishing effective cognitive training while avoiding Foshay et al 's (2003) theoretical and industry limitations requires considerable planning and research The transfer of expert decision making capabilities from veteran commanders to junior decision makers quickly can be accomplished through cognitive training One cognitive training method that shows promise for this purpose is the use of comics Though often considered by many to be overly simplistic, comics have the potential to dramatically improve cognitive training in ways that are not possible by using other media Studying comic use for training is one example of cognitive research that may improve decision making training by the military, saving money as well as lives on the battlefield

Problem Statement

The purpose of the current study was to examine comics as an effective medium for training military decision makers Submarine officers were presented with a comic

strip depicting either a fire or an attack while aboard a diesel submarine and were required to complete decision making tasks based on the comic's contents

Comics were selected as a potential alternative for cognitive training because of their lower development time, higher cost effectiveness, and better potential for universal communication compared to other training media

In the following paragraphs, several cognitive theories are explored and then the author emphasizes particular decision theories that form a basis for training expert decision making General training, cognitive training, and decision training are described The language of comics is described and analyzed, compared to other training media, and related to the cognitive processes that underlie decision making

Cognitive Theory

An understanding of expert decision making begins with a consideration of mental information flow and cognitive processing of environmental stimuli According to Multiple Resource Theory (MRT), sensory information is first manipulated by receivers with the help of four resource dimensions (Wickens, 2002) These four dimensions consist of perceptual modality (auditory and visual processes), processing code (spatial and verbal), processing stage (perceptual, cognitive and response), and visual channel (focal and ambient) Visual channel may be considered as a subordinate division of visual process Each dimension relates to processes that are limited in capacity For example, too much auditory information can overwhelm the operator's mental capacity for additional auditory stimuli However, if visual information is used in addition to sound, separate resources can compensate for this restriction The mental processing demand that a task imposes is called workload

As perception continues, selecting the most important information for further processing helps to alleviate workload and improve task efficiency For example, when visual processing is overwhelmed, perceivers may selectively attend to important visual information while attenuating all other data This means that properties of objects, or object features, are perceived but total object recognition is not fully achieved (Treisman, 1986) This is the pre-attentive stage where certain object cues, such as color, size, contrast, tilt, curvature, and line ends are seen without having to allocate attention to the overall object Attention to select information occurs after properties of objects have been perceived and important object features selected Unnecessary objects are filtered out and only essential information is left to mentally process and recognize Once a mental representation of the object is formed, it is then compared to objects in memory, completing object recognition The process of attending to important information while disregarding other information is the focus of Treisman's (1986) selective attention research If, for example, attention to tactics is more important than strategy, then trainees would perceive tactical operation information while ignoring strategic information This process, known as cue selection, is necessary when making decisions

Battle planning includes a significant amount of decision making Decisions are generated from information received, and information enabling cue selection can be overwhelming and confusing Regardless, expert military commanders must make decisions when many sources of information are active simultaneously A number of decision making theories have been proposed to explain how experts selectively restrict information to make a decision

Decision Theory Expert decisions are much more complex than everyday decisions To appreciate this complexity, it is important to first understand basic theories of decision making One basic decision making theory is the Subjective Expected Utility (SEU) Theory According to SEU Theory, decision makers take minimum and maximum payoffs into consideration (Wright, 1984) This theory is subjective because in every situation, the probabilities can change based on the individual's knowledge or perspective SEU focuses on the expected outcome of that individual, or what he or she anticipates Utility refers to the amount of payoff For example, if the best possible situation occurs, the payoff or utility could equal a maximum of 100 percent This number and metric can change to represent the maximum utility that makes sense for a given situation

SEU is a mathematical decision theory that weighs probabilities of risk with desired outcomes (Wright, 1984) If researchers adhere to SEU Theory, the rational (mathematical) choice should be selected rather than the choice that reflects individual intuition or preference The product of this theory is the optimal decision based on given, structured criteria, such as expected losses versus gains Criteria can be mapped onto decision trees to easily view possible situational outcomes SEU is an important theory because it provides a basic understanding of decision making for simple circumstances, however, it does not explain inconsistent choices such as those swayed by personal preference

For example, there are many situations in which people make illogical decisions, skewed by an aversion to risky circumstances, a desire to win, or a need to conserve resources These types of decisions can be defined by Prospect Theory (Tversky &

Kahneman, 1985) Prospect Theory builds upon SEU Theory but expands it to include both an individual's preferences as well as framing Individual preferences, such as the perceived attractiveness of a scenario, can influence choices In addition, how a scenario is worded can increase or decrease its attractiveness to the individual

According to Prospect Theory, framing a problem in different ways skews decision making (Tversky & Kahneman, 1985) Tversky & Kahneman (1985) give the following example Subjects are asked to imagine having $20 dollars In the first scenario, a person pays $10 for a theater ticket but subsequently loses the other $10 In this situation, most people replied that they would still see the play However, if $10 were paid for a ticket and the ticket was then lost, most people said they would not pay for another ticket Even though $20 was paid for the play in both scenarios, the first scenario was preferred In the first scenario, the lost money is not connected to the cost of the play The perception of the ticket costing $20 in the second scenario is clearer because the person is physically buying the ticket twice

In the military, area commanders are faced with complex situations and must avoid personal preferences when making decisions For example, area commanders judiciously disseminate critical intelligence to ship captains to ensure mission success Area commanders and submarine captains are on the same team and relay information to assist with decisions Area commanders do not intentionally shape or influence the submarine captain's decision, however, given the large amounts of intelligence available, the area commander must choose which information to relay to the submarine Logically, the area commander will select the intelligence that he or she believes is the most pertinent and actionable The submarine captain's decisions will be shaped by

which intelligence is forwarded, but not by intentional omission of critical information Even with the best intentions, however, area commanders may not choose the correct intelligence to promulgate, and this will dramatically impact the submarine captain's decisions

Decision makers, such as the submarine captain, are usually unaware that framing affects decision making (Tversky & Kahneman, 1985) When a scenario is framed, other ways of understanding the scenario are generally disregarded Decision making becomes skewed when individual desires prevent decision makers from choosing rationally Unlike SEU Theory which is based on probabilities, Prospect Theory considers how human emotions and perceptions affect decision making

Prospect Theory describes how decisions are swayed positively or negatively from a neutral reference point when a scenario is presented Every individual decision maker has a neutral reference point, when initially faced with a scenario, perceived losses and gains have not yet been determined because they can change with each scenario

For example, in a situation where a ship captain sends two sailors on a mission and they do not return to the ship as scheduled and a positive report of mission accomplishment was not received by the ship, the captain has two potential reference points If the captain considers that only two sailors are lost, he or she might not send any others to search for them if it risks the lives of the rest of the crew However, if the captain believes that the lost sailors might be recovered if other sailors searched for them, then the captain would bear the risk of losing other sailors Also, if the mission was vital, then the captain would be obliged to send additional men to ensure mission accomplishment In the military, nothing is more valuable than the sailors' lives and the

captain's decisions are directed toward the survival of his sailors Theoretically, the neutral reference point changes prior to making a decision based on perceived loss versus perceived gain

Neither SEU nor Prospect Theory, however, can explain complex, risky decision making, expert decision making in extreme conditions is dramatically different than everyday decisions or choices made during experimental scenarios Expert decision makers rely on a combination of experience and analytical skill to navigate highly critical real-world situations that are not typical everyday occurrences and are not easily replicated in experimental scenarios

Expert decisions are necessary for dangerous real-world environments that include unstructured problems, uncertainty, shifting goals, feedback loops, time constraints, high stakes, multiple players and organizational goals and norms (Orasanu & Connolly, 1995) NDM refers to intuitive rather than analytical processes (Ross et al , 2004) According to NDM, expert decision makers rely on experience, training, and knowledge to determine the best decision options in a scenario (Klein, 2008) This option is called the Course of Action (COA)

In the military, for example, the ability to recognize patterns in surveillance monitoring is developed with training and experience Surveillance monitoring helps military decision makers understand enemy operations By collecting data and understanding how enemy forces have operated, their future actions can be predicted Once the enemy force's future maneuvers have been predicted, a COA can be determined

The mental process of matching current and previously experienced situational patterns requires the use of schemas (Zsambok, 1997) Schemas are developed mental structures that combine many elements into one for a specific purpose or function and allow humans to store and retrieve experiences (Paas, Renkl, & Sweller, 2003) Matching patterns rather than choosing alternatives is the defining activity that separates NDM from other decision making theories

NDM methods are more generalizable to military decision making than SEU and Prospect Theory because NDM incorporates many critical elements (e g , uncertainty, time constraints) where decisions are not based on simple probabilities Although Prospect Theory includes human desire as a part of decision making, it assumes a straightforward decision making process based on distinct, easily understandable scenarios This is not the case for military scenarios Military decision making theories must incorporate every aspect of environmental variability so that their recommendations for training are not misleading

For example, submariners must incorporate information such as political events, oceanographic movement, and warfare maneuvers prior to making a decision Critical decisions made on a submarine could affect every member aboard the sub and, more importantly, the wrong decision could result in an international incident Submariners must make decisions based on limited information and come to conclusions based on experience, using NDM methods

Training

General Training There are five general elements that contribute to successful training rationale, objectives, activities, evaluation, and feedback (Stolovitch & Keeps,

2002) Training rationale is an explanation or reason for trainees to learn new information Rationale can also be presented to trainees as a guide for their own discovery Objectives are the concise and measurable end goals of the training process Activities are exercises given to trainees by trainers, such as question and answer sessions based on example scenarios, to assist trainees in achieving set objectives Evaluation is the assessment of trainees' abilities to learn training objectives including both the training process and the outcome Feedback should be provided to trainees so that their level of objective attainment is understood Feedback should occur throughout the training process rather than just at the end (Stolovitch & Keeps, 2002)

The military's rationale for training is to improve soldiers' job or task performance to meet mission requirements (Department of the Army, 2008) Objectives are clear and distinct for each soldier's particular job and task because it is based on the standards that are set forth by the military's upper chain of command For example, soldiers may be required to receive training on a certain type of weapon and perform to their command's standards Activities can include a range of media from text-based materials to real world exercises Evaluation and feedback are a constant throughout each training experience

Military Training Procedures Although military training generally follows the five-step training model described above, the military also utilizes its own circular training process (Department of the Army, 2008) Individual and organizational performance is assessed to locate weak areas in need of training The weak area is trained through various media to accomplish goals set by higher commands Training, coaching, counseling, and after action reviews (AARs) provide trainees performance

feedback This cycle of locating, training, and testing weak area(s) continues, ensuring that the weak area becomes strong and that other areas are also at satisfactory levels Rationale and objectives are generally related to job or task improvement General training concepts can be applied to almost any job or task Cognitive tasks, such as decision making, however, require cognitive training In the current study, the training cycle will not be completed as participants will not receive feedback after they submit their answers

Cognitive Training The Cognitive Training Model consists of five steps that trainers should follow to help trainees accomplish learning goals (Foshay et al , 2003) selection of information, linking, organization, assimilation, and strengthening of new knowledge Selection of information is important because it helps trainees understand which information is necessary and which can be left out, as discussed earlier with Treisman's (1986) selective attention research in which certain cues are attended to while others are ignored By pointing out important cues through training media, trainees can learn which cues to attend to in real-world scenarios

Linking is the process of connecting new information with existing knowledge Recall and relate are two components of linking (Foshay et al , 2003) Recall is the process of bringing previously learned concepts to the forefront of the trainee's awareness so that new information can be built upon them Lectures, discussions, or other methods can be helpful for enabling recall Relate is the process of bridging existing knowledge with new material by noting similarities and differences Integrating new information with previous knowledge is a part of the organizational stage Organizing information in a way that stresses relevant information minimizes mental

processing and confusion This can be accomplished by grouping information, or providing trainees easily understandable pieces of larger training concepts through text and illustration

Trainee assimilation of information is a process of mental information reorganization (Foshay et al , 2003) Assimilation can be facilitated by presenting new information through real-world examples This solidifies an understanding of new information with related existing knowledge Strengthening the new information can be accomplished through practice, feedback, summarizing, testing, and applying it on the job

In the military, trainees often perform learned tasks on equipment After trainees practice a task, trainers provide feedback, often in formalized after action review sessions During the process, trainers typically summarize concepts for the trainee by presenting the structure or framework of learned material For example, trainers can reiterate proper steps for performing a task on equipment Testing can be accomplished after practice, feedback, and summary by allowing trainees to perform the task again and demonstrate that they have met training objectives

Cognitive Training for Decision Making Cognitive training is often used to improve trainees' decision making abilities by improving their situation awareness, ability to match patterns, and ability to identify cues (Klein, 1997) Trainees can also learn how to manage uncertainty and time pressures by practicing trained scenarios under stressful or time-critical conditions All of these decision making criteria can be evaluated by using Van Den Bosch and De Beer's (2003) critical-thinking training measures, as described below

Researchers can use the critical-thinking training measures that include training processes and training outcomes (Van Den Bosch & De Beer, 2003) Training processes include the decision maker's choice of critical-thinking strategy and are evaluated by examining learner information processing and argumentation Information processing includes measuring a trainee's ability to detect incomplete or contradictory information, build a story, and select pertinent information Argumentation is the trainee's ability to explain incomplete or contradictory information, develop alternative explanations, and assess assumptions

Critical-thinking outcomes are an end product of training and are evaluated by examining results and contingency plans (Van Den Bosch & De Beer, 2003) Results are a measure of trainee performance, such as the demonstrated ability to correctly perform a specific task after a training session Results are based on the trainees' communication, actions, plan quality, and total time taken Contingency plans are how likely the trainee is to anticipate alternative decisions as well as the quality of the alternatives

Critical-thinking training uses NDM as a foundation by including elements of NDM such as the use of experience to assist with ambiguous situations, assessment of unreliable data, and a preference for action over contemplation (Van Den Bosch & De Beer, 2003) Although the terminology is different, critical-thinking training and expert decision making are both supported by NDM research, both emphasize the necessary use of experience for handling critical situations, evaluation of time under stressful conditions, and processing ambiguous, incomplete, and inconsistent information Ultimately, NDM and critical-thinking training rely on one another NDM is the

foundational framework for decision making research, and critical-thinking training applies NDM for the improvement of performance

The goal of cognitive training is to quickly and reliably create expert decision makers in complex situations Expert decision makers should make high-quality real-world decisions, showing flexibility and adaptation to changing environments and conditions, quick responses, resilience to severe stressors, the ability to assess risk, and accurate judgment of decision applicability (Klein, 1997) Experts are able to process critical cues conceptually within a scenario (Van Den Bosch & De Beer, 2003) Novices, however, absorb critical cues literally and have difficulty forming a collective vision of situational events To transform novices into expert decision makers, NDM based scenarios should be used to teach trainees how to make expert decisions Critical-thinking training measures such as training process and outcome assessments should be utilized to evaluate trainees' progress The appropriate training medium, however, must be determined, considering factors such as generalizability across trainee type and situation

Which Training Medium is Most Generalizable?

The ideal medium for cognitive training in the military is debatable The military utilizes many cognitive training media including video gaming, text, videos, Powerpoint slides, hands-on training, virtual reality (VR) based simulations, classroom lectures, and real world training exercises with other combatant units (Department of the Army, 2009, Sontag & Drew, 1998) Though the military has used many methods to train military men and women to make complex decisions, comics may alleviate several limiting factors of other media such as high development costs, inability to change or update

training materials quickly, excessive time required for learning, and obscure or counterintuitive materials format

According to Van Den Bosch and De Beer (2003), expert cognitive training should include three elements practice that is intense and purposeful (Ericsson, Krampe, & Tesch-Romer, 1993), relevant scenarios to engage situation assessment and decision making processes (Klein, 1998), and recognizing and exploiting interdependency of scenario elements such as time pressure and critical cues (Cohen, Freeman, & Thompson, 1998) The end goal is for trainees to develop expert decisions under uncertain circumstances

Comics It is likely that comics can be used effectively as a cost-effective medium for decision making training, addressing each of Van Den Bosch and De Beer's (2003) three elements Van Den Bosch and De Beer's (2003) first element, purpose and intensity, can be manifested through comic movement, space, and time People read, contemplate, reflect on, and discuss comics without limit or time constraint In terms of "intensity," comic artists typically augment the presentation of a scenario with action elements such as explosions, vivid color, and jagged lines (McCloud, 1993) The second element, relevant scenarios, was envisioned in the current study, complex military scenarios featured team oriented missions, time pressure, high risk for survival, and military forces from foreign countries The third and final element, the interdependence of scenario elements (e g , time pressures and critical cues), was represented by emphasizing scenario elements through comic techniques such as bold lettering, symbols, or arrows to emphasize points of interest

In addition to meeting Van Den Bosch and De Beer's (2003) criteria, using comics for expert cognitive training is supported by Sensorimotor Contingency Theory (Noe & O'Regan, 2002) Sensorimotor Contingency Theory contends that visual perception of objects is enabled by experiencing movement of those objects and by interacting with them Sensorimotor contingencies reflect the perceiver's interactions, and anticipated actions, with objects Interactions with objects occur through the senses and coordinating exploratory physical motions that ultimately form a visual perception of the object For example, as a car moves along a dark road, its headlights shine upon certain objects within the environment If the car shifts position, its headlights shine upon a different set of objects The way that the car moves depends upon environmental constraints and what is visually perceived within the environment depends on how the car moves Noe and O'Regan (2002) state that neural activity in the brain is necessary for humans to experience vision However, vision is not a product of neural activity, but of the sensorimotor activity of the perceiver Therefore, interaction between a perceiver and an object (visual stimulation) causes neural impulses but sensorimotor activity develops the visual experiences

A comic symbol, such as the car in the previous example, can become a catalyst for many of the reader's visual experiences because comic symbols are often exaggerated, allowing more extensive cognitive processing of objects For example, a comic symbol of a car reveals what the car is, and through visual exaggeration or emphasis causes the reader to consider past and anticipated experiences with cars A variety of experiences and alternative information is relayed with a single comic symbol, providing present information about the car as well as possible future or anticipated

information In contrast, typical text descriptions of the same car would be comparatively sterile, limiting a reader's cognitive processing to a specific time, space, and application

Although photographs of cars do not allow for the same visual exaggeration as a comic drawing of a car, photography has provided a basis for some comic exaggerations Lines drawn behind a car to show movements were not always an understood addition Camera shutter speeds have improved over many decades, allowing photographers to capture movement in blurred imagery (Miller, 1990) Comic artists understood the blurs as objects in motion and recreated the blur as lines behind objects to communicate movement Miller (1990) refers to these as, "whoosh lines " This type of drawing is a non-literal representation of movement that is an artifact of photography, namely a pictorial metaphor (Kennedy, Green, & Vervaeke, 1993)

Pictorial metaphors are the lines drawn that would not normally be present in an image These lines can represent movement, or the senses, such as pain (Kennedy, et al , 1993) These lines are often used in comics to communicate feelings and motion that cannot otherwise be expressed through a static image

To understand the communication between comic and reader, it is important to examine the precise definition and distinctive elements of comic presentation In the following paragraphs, comics are fully described to separate them from other similar methods such as storyboarding Comics are an art medium consisting of adjacent, intentionally sequential images (McCloud, 1993) Comics are art forms that relay a message In other words, comics are the "messenger," (McCloud, 1993) The content,

whether humorous or otherwise, is the message The message is at the artist's discretion, whereas the art form remains unchanged

Though often related to comics, storyboarding has an entirely different purpose A storyboard is made of simple sequential sketches that may appear similar to comic panels Panels are removed in storyboards, leaving the same sized blocks of space and time for each image Storyboarding text is placed separately below imagery whereas comics integrate text within balloons or comic panels (Eisner, 1985) Comics are meant to be read whereas storyboards connect movie scripts with final photographic staging such as camera angles and character placement The purpose of storyboards is to visualize another form of media such as websites or movies (Storyboard, 2009)

In contrast, comics are not designed as an accessory to some other medium, but rather are a stand-alone art form Furthermore, comics represent an art medium, not simply an object like a comic strip or comic book (McCloud, 1993) Such objects deliver the comics, as well as their message, to the reader Although often humorous, comic expression may range from fictional action to serious commentary Cartoon strips are usually shown in a few comic panels, given limited space in a newspaper, to describe a humorous situation or thought However, comic novels, such as the 1987 novel "Watchmen," have a limitless range in terms of comic panels, pages, and even book series to depict action, serious storylines, and tragic circumstances

The investigation of comics as a cognitive training medium has been in part prompted by their popularity, demonstrated by the large annual revenue in comic sales In Japan, comics ("Manga") are a much bigger industry than in the United States (Rhoades, 2008) Worldwide Manga sales exceed $5 billion annually This figure does

not include other consumer products that are based off of the comics such as action figures, clothing, and video games Manga revenue surpasses all comic sales in the United States combined annually--in a single week Comics enjoy broad appeal, transferring information across countries without age, race, or other demographic boundaries Such wide appeal is ideal for military applications, because of the considerable diversity that characterizes service men and women Comics are popular regardless of a soldier's experience level, foreign duty, duty position, age, race, socioeconomic background, sex, education, or rank Aside from their theoretical relevance, the ability of comics to communicate to diverse populations within the military suggests that they can be highly effective for training

Comics are Inexpensive, Flexible Comics are often simply ink on paper, however, they may also be digital images In either case, comics are inexpensive to develop in comparison to some training media (e g , virtual simulations), that require extensive time or material for development Comics are also more easily changeable if mistakes occur or updates are necessary, whereas computer simulations could require teams of computer programmers and modeling and simulation designers to redevelop training materials Comics have similar benefits in comparison to text-based media and lectures

Text-based training media usually exist in the form of training manuals, books, or published articles, and take longer to rewrite and to read than comics because of their length and conceptual detail Rather than using a few simple comic pictures with minimal dialogue, literature based descriptions of events may require pages of

explanation Lectures require trainers and trainees to schedule repeated meetings to discuss curricular issues when mistakes or rewrites demand material modification

Comics Stand Alone Powerpoint slides are meant to provide an outline of lengthy text, or to provide structure for lectures In the military, Powerpoint slides are often provided to trainees as a stand-alone training guide (Johnston, 2005) By providing an outline without complete details, important concepts may be lost or misinterpreted Comics, however, can be used effectively as a stand-alone product because the comic images can be exaggerated which constitutes an advantage over images that are static in Powerpoint slides Comic imagery can emphasize important concepts and highlight details so that imagery is concise and understandable without losing important information

Comics Show Motion Computer animations and videos can be used to show on-the-job training procedures Comics, however, mix the benefits of static and dynamic emphasis (McCloud, 1993) Comics also allow the reader an unlimited amount of time to view and, more importantly, review the comic panels at their discretion (Eisner, 1985) Comic readers can effortlessly review previously learned steps rather than rewind videos or animations Mentally processing and understanding information is more easily attained when the pressure of timed presentations, such as videos, is removed

Comics are Accessible Comics can be utilized at any place and time, using a variety of media Comic panels can be scanned and viewed in the same way as a printed manual (Eisner, 1985) Entire comic pages can be scanned and viewed on screen or comic panels can be shown separately depending on alterations needed for screen

reading Military trainees can learn essential material whether in their racks at home port or on a computer while deployed

Perhaps the most desirable training for military personnel is live range training Such training regularly occurs at dedicated military bases such as the National Training Center at Fort Irwin, CA However, live range training requires extensive resource coordination and cost, paying hundreds, possibly thousands, of soldiers or sailors to operate complex equipment for training is prohibitively expensive As a result, such live training occurs rarely During live-fire training down-times, comics can be used as additional training to refresh soldiers between real-world exercises Though perhaps limited in terms of the complexity of tasks supported, comics can be quickly accessed and require limited resource coordination

Comics Facilitate Retention According to Cognitive Load Theory (CLT), instructional designers should consider cognitive processes and limitations to increase the efficiency and effectiveness of learning (Paas et al , 2003) Relevant cognitive processes include working memory, long term memory, and schemas (cognitively structured experiences) (Zsambok, 1997) Working memory is the active area of mental processing that is used to control processes such as manipulating visual images, perceiving spatial qualities, and making decisions (Baddeley, 1998) However, working memory can hold only a few interacting elements (Paas et al , 2003) Long term memory contains many schemas and stores information for extended periods of time (i e , years) Schemas from long term memory can be utilized in working memory during a task where a particular experience is necessary Knowledge of these cognitive processes is essential for understanding how retention works Training media can exploit a multitude of learning

elements, creating greater impact on cognitive processes and ultimately maximizing retention

Cognitive load, or the demands on the capacity of working memory, can be increased by training curriculum element interactivity (Paas et al , 2003) High element interactivity features information or concepts that share many combined elements that learners must process together to gain a complete understanding of the concept Critical situations that require expert decision making, such as those faced by the military, can include multiple variables that interact and must be understood and trained together

For example, submariners train for major ship casualties that might occur during wartime scenarios When a submarine is in combat and the mission is to shoot another submarine, life-threatening factors might affect the mission A fire that is unrelated to the enemy battle could occur on the submarine, however, the mission may take priority depending upon the importance of the mission While potentially life-threatening, a fire may realistically be combated while also engaging the enemy These separate elements are trained together so that sailors understand their priorities and are able to make accurate decisions when faced with highly stressful conditions High element interactivity in military training, such as in the previous example, can be shown through comics

The United States Army published Eisner's (1985) military training technical manuals in the form of comics each month for over twenty years Comics spanned topics including, but not limited to filling a grease gun, warhead unpackaging, disengaging, and prefire (Eisner, 1985), and M-16A1 rifle operation and preventive maintenance (Eisner, 1968) In these technical comic manuals, military tasks are demonstrated sequentially

through comic panels, facilitating the step-by-step training process (Eisner, 1985) Eisner also developed comics that were meant to emphasize a particular attitude during a task Trainees learned attitudes through imitation of characters, which was exaggerated in comics to direct trainees' attention and make a point about the situation Eisner trained many people to perform a variety of tasks using comic imagery Moreno (2007) has extended the idea of training with segmented media presentations, such as comics, to include retention of learned material

Moreno (2007) discussed how dividing animations and videos into smaller portions and removing extraneous information can facilitate retention of learned information This segmented, or simplified, approach also lowers cognitive load by reducing working memory processing (Mayer & Chandler, 2001) Comics can be utilized to train high element interactivity concepts while accommodating cognitive processes and limitations

Many other training media (e g , Powerpoint presentations, simulations) increase cognitive load because interfaces and instruction are designed without considering cognitive capacities (Paas et al , 2003) Comics provide essential information for training while maintaining important details, lowering working memory processing and cognitive load, and improving retention and learning Eisner's (1985) early work showed that the military's high interactivity material can be expressed through comics by incorporating situational elements such as political, wartime, and technical issues Moreover, comics' powerful pictorial language is based on universal, innate human abilities called image schemas (Mandler, 1992)

The Power of Comics – Image Schemas

Image schemas are mental structures (Mandler, 1992) formed by the combination of environmental spatial structures and innate tendencies Essentially, humans are not born with a pre-written understanding of the world waiting to be opened like a wrapped package Rather, we are born with image schemas that may be elaborated to create such an understanding Shortly after birth, every human goes through an image manipulation 'language' before speaking, reading, or even understanding a particular culture's language (Mandler, 1992) As human learners interact with the world, they build upon the existing elementary mental framework, creating larger schemas

Comics utilize image schemas that encourage basic human understanding and convey a message that can be understood by humans of all age, race, or culture (Mandler, 1992) Rather than examining the lines and points on each image, or the actual ink on the page, readers use image schemas to interpret comics, and this broader perceptual element drives comics' ability to communicate and transfer information to diverse populations (Knox, 2004)

Types of Image Schema Image schemas are perceptually based notions that help humans understand events within their environment (Mandler, 1992) Specific image schemas that are important to our understanding of comics include PATH and LINK PATH describes trajectory, it does not specify details of the object, but solely the physics behind a moving object through space LINK refers to perceptual structure, the connection between parts of an object such as legs attached to a human body PATH and LINK work together, for example, when a human walks

With the image schema PATH, an object that moves along a trajectory starts in one position and follows the arc to an ending position The object must continue until the object falls to a landing position or is interrupted along the path If a ball is thrown upward, for example, the ball continues further away until gravity pulls it back down A sense of continuous motion and time based on the speed of the ball are incorporated into this single event If comic readers imagine the ball being thrown upward, and then landing, we assume that the ball was at one point in the air – even if we did not see it We've completed the PATH image schema without seeing the entire event Comics often assume tacit knowledge resulting from PATH image schemas by deleting portions of a scene without changing the story In other words, comics provide a part of the story, knowing how human perceivers will complete it

For the military, many objects can be placed in motion and follow certain paths such as missiles, bullets, and aircraft If a missile, for example, is shown in a comic panel, soldiers can understand its trajectory without having to view the entire route taken The PATH image schema is useful to the military because images can be shown succinctly and without full description and military trainees can still retain a full understanding of the training material

The LINK image schema provides the same affordances When a character walks in a comic strip, only one image of the walking motion is necessary for the reader to understand how the character's limbs move while attached to the body The LINK image schema applies to all character motions such as sitting, dancing, or jumping In every circumstance, the reader knows where the character's limbs are attached and where they are free to move LINK image schemas also apply to any dynamic object such as wheels

on a car, keys hanging on a keychain, or string around a yo-yo For each object, connecting or linked points are understood because these experiences are a part of every human's schema and can be applied to new situations For example, when a character walks while throwing a yo-yo downward, the reader expects the yo-yo to spiral back up the string to the character's hand – even if that event is not specifically depicted LINK provides connecting points among structures, such as characters and objects, so that movement among comic panels is seamless

Image schemas are important because they remove almost all demographic boundaries such as level of education, language, age, occupation, and culture Both real and imaginary experiences, from walking to flying a space ship, are understood because fundamental elements that explain how movement occurs, or image schema, are known to every human being Comics are a form of communication that spans across demographic boundaries and even time periods Comics drawn decades ago are still understandable because as the key to human understanding, image schemas are unchanging

The use of comics to communicate training objectives across diverse populations is more effective than other training media because of the universal 'language' within comics The image schemas used within comics allow for training to progress more quickly and completion time can be shortened with greater clarity and understanding of training material For example, the use of PATH and LINK image schemas support the goal of using comics to train military members by providing a means for understanding how specific image schemas work and providing a basis for understanding symbology in comics PATH and LINK increase the applicability of using comics as a military training

medium because all humans have these image schemas and diverse populations, such as the military, can benefit from training materials that build on this sort of universal communication

The Role of Gestalt Perception Some researchers believe that the PATH and LINK effects exist because of the Gestalt principles of perception, described in the early 1900's (Humphrey, 1924) Gestalt principles describe the way in which humans organize visual information (Humphrey, 1924, Pomerantz, 2006) One of the basic Gestalt principles is that perception of an entire image does not equate to the perception of its parts To further explain, observer perception of one image may dramatically change when another image accompanies it This change can be explained by the Gestalt law of similarity (Kubovy & van den Berg, 2008) The law of similarity states that objects with similar features, such as shape or color, are perceptually grouped together For example, several columns of dots are perceived as either rows or columns Several alternating columns of dots and squares are perceived only as columns, the addition of squares forces a grouping of similar images This is important to note because the perception of images in comics defines the 'language' of comics, or the reader's understanding of the comic images Comics use symbols to communicate ideas to the reader By understanding which part(s) of the symbols are most important, or if the symbol is perceived as a whole, the 'language' of comics is better understood and ideas can be better communicated to the reader

Pre-attentive mechanisms, such as perceptual grouping, are mentally processed before attention to an object occurs (Treisman, 1982) The perception of columns is formed because of perceptual grouping However, there is more to this concept than

merely grouping similar items First, certain elements of the entire image must be grouped, called element clustering (Trick & Enns, 1997) When columns of squares are added to columns of circles, squares are clustered together, separately from the circles that are clustered Second, the shape, such as a line in or column, must be determined after the cluster is formed This is called shape formation All of these cognitive events occur prior to attention-demanding mental processes so that when attention is necessary for processing motion, the mental image, or form, of the perceived shape does not diminish

These concepts apply to comic images as well Shape formation is necessary when comic readers perceive motion across comic panels As the images change from one comic panel to the next, the reader must be able to mentally group elements, such as lines and dots, together to visualize streamlined movement rather than a jumbled group of lines and dots For example, if a column of dots is drawn on the left of a comic panel, and then drawn on the right of a second comic panel, the column would appear to move from left to right Without shape formation, the dots would not be grouped and motion would not be perceived

The Gestalt principle of good continuation could describe the perception of motion in comics The principle of good continuation states that an image or pattern continues on a visual line, even with pattern obstructions such as empty space The line must be adjacent to its continued part For example, if a ball were thrown in a direct line across several comic panels, the principle of good continuation could apply However, if a ball was thrown upward in one comic panel and then caught in another panel without the trajectory shown, the principle of good continuation would not apply because it does

not account for the missing arc In most cases, motion in comics occurs in lines that vary in trajectory

Overall, Gestalt principles are important but difficult to standardize (Pomerantz, 2006) Developing metrics for Gestalt principles has been shown to be challenging for researchers One reason for such frustration can be attributed to other mental processes that interact with visual perception (Kimchi & Hadad, 2002) Kimchi and Hadad (2002) discuss the idea that familiarity of objects changes perception Familiar, upright letters were recognized by participants more quickly than unfamiliar, inverted letters This shows an interaction between the letters shown, or the raw data, and the previous experiences stored in the participants' long-term memory (Noordman & Vonk, 1998) This is important because it shows how experiences in long-term memory affect the perception of letters, or symbols, such as symbols used in comics Along with knowledge in long-term memory, sensory information is also necessary to perceive comic images

The mental processing of raw data, or sensory information, such as the letters on the paper is called bottom-up processing (Noordman & Vonk, 1998) Understanding the letters is based on knowledge which is stored in long-term memory Knowledge-based information that influences perception is top-down processing This interaction between bottom-up and top-down processing allows for faster recognition of visual objects, such as letters (Kimchi & Hadad, 2002) and allows for better understanding of the information read (Noordman & Vonk, 1998) Bottom-up and top-down processing are important in comics because these processes emphasize how sensory experience and knowledge play a part in the perception of objects In other words, if comic readers did not have any

previous knowledge about the images in comics, their recognition would be slower and their understanding would be less than others with prior knowledge Also, sensory information is necessary so that experiences stored in long-term memory have an associated image Because comics are easily understood across diverse populations, sensory information and prior knowledge may be the catalyst for researchers to fully understand the mental tools that comic readers utilize when reading comics

Through Kimchi and Hadad's (2002) interactive mental processes and Treisman's (1986) pre-attentive mechanisms, including Trick and Enns' (1997) element clustering and shape formation, researchers can understand how visual perception occurs These studies explain a few of the missing links in Gestalt principles by adding experience as an interactive perceptual element and bringing light to the perception of symbols in comics

This is important for military comics because bottom-up and top-down processes also apply to soldiers' visual perception of military comic symbols If, for example, a real-world military exercise occurs, combining various military groups such as submariners and pilots, and is too expensive to be coordinated more than once in several months, then comics can be used to reinforce training elements previously learned The knowledge-based information, or top-down processing, learned from the real-world exercise is reinforced by showing comic images that represent places or things within the real-world exercise and by using scenarios that are similar to those experienced The bottom-up processing occurs as the soldier mentally processes the letters and images on the comic pages The interaction of top-down and bottom-up processing is essential to learning by military members, and comics are an alternative training tool Whereas other forms of training are difficult to coordinate, expensive, or otherwise unavailable, comics

can be used to reduce expenses and continue the cognitive training process Interactive mental processes apply to static imagery, however, comic readers are still able to perceive motion in comics

Stroboscopic movement might explain the perception of motion in comics Stroboscopic movement refers to the perception of motion when images with slight changes are shown rapidly in succession (Gazzaniga & Heatherton, 2006) This tendency is assumed and exploited by film makers If the time between static images is less than 30 milliseconds, two images are perceived at the same time, images are perceived separately if they are more than 200 milliseconds apart At between 60 and 200 milliseconds, motion is perceived This perceived motion is called the phi phenomenon

In comics, framed images are placed in sequence to show motion The frames are not shown in rapid succession, however, viewers are still able to infer motion across the static frames (Figure 1)

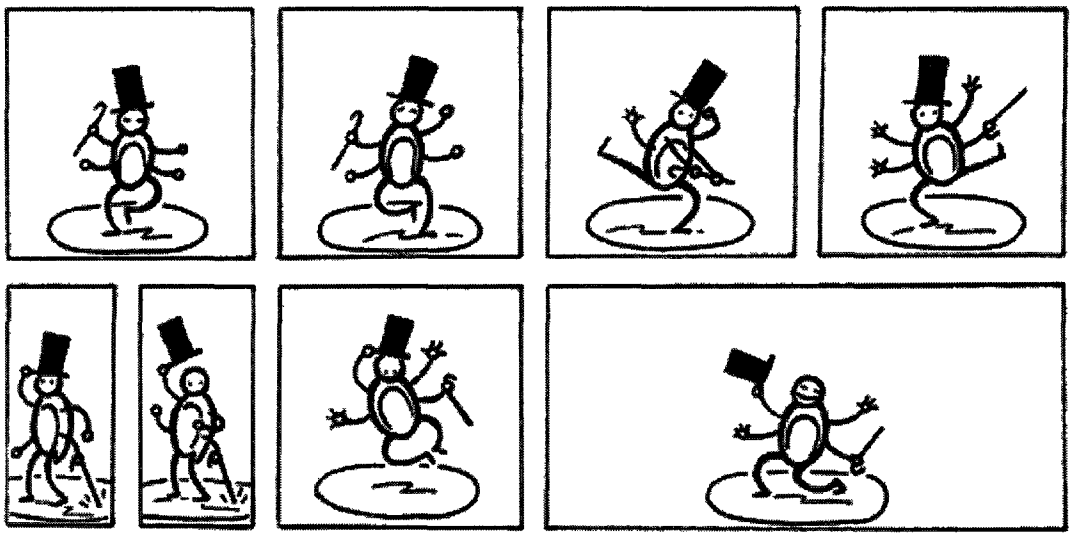

Figure 1 Comic Strip Example of Inferred Motion

(http //comixtalk com/images/mar2006/dancinbug png)

The inference of motion in comics is not due to the phi phenomenon, but is understood through previous knowledge and experiences, the top-down and bottom-up processing previously discussed When movements, such as dancing, are experienced, this information is stored in long-term memory and can later apply to new situations, such as inferring a similar motion in comics Comics are an alternative to movies because the conceptual understanding of scenarios is just as effective Motion is inferred without requiring actual character motion because humans can piece the comic panels together mentally

In the military, conveniences such as computers might not be available to present movies or animations In these situations, printed comics should be used because they allow readers to perceive motion without animation Because of potential environmental constraints, it is important to provide effective military training wherever possible For

military training where computers are available, comics presented in either hardcopy or digital format, can be used as an effective alternative to movies

Many different theories can be used to explain how comics communicate to a widely diverse audience Gestalt principles, for example, seem to work part of the time Comics defy other concepts entirely, like phi movement Sensorimotor contingencies, schemas, image schemas, pre-attentive mechanisms, and interactive mental processing theories, however, apply to the perception of comic imagery and symbols

Symbolism in Comics

Symbols are intentional, meaning that any image can represent any concept (DeLoache, 2007) Images perceived might be similar but can represent different concepts (Salsa et al , 2007) Slight visual changes between images, or different surrounding images, create a wide range of symbols

Humans recognize text and pictures as symbols as young as 18 months after birth (Preissler & Carey, 2004) Symbols are used within comics to communicate simple ideas as well as intangible sensory information and concepts, and the inherent comprehension of symbols allows comics to appeal to diverse populations such as those represented within the military

Symbols are important for the military because they are used widely in computer interfaces and printed materials for warfighting operations and training (Department of Defense Interface Standard, 1999) The military uses symbols to represent units, equipment, installations, military operations, signals intelligence, meteorological and oceanographic forecasting, and military maneuvers that are not specifically designed for use during wartime The military's MIL-STD-2525B classification system standardizes

symbols by description, hierarchy, frame, and affiliation Symbol description is the operational terminology of each symbol by its individual parts For example, an underwater weapon such as a torpedo has the description Subsurface Track, Underwater Weapon, Torpedo (Figure 2) The name of the weapon, the type of weapon, and its location (e g ground, subsurface, air) are all essential elements of the symbol

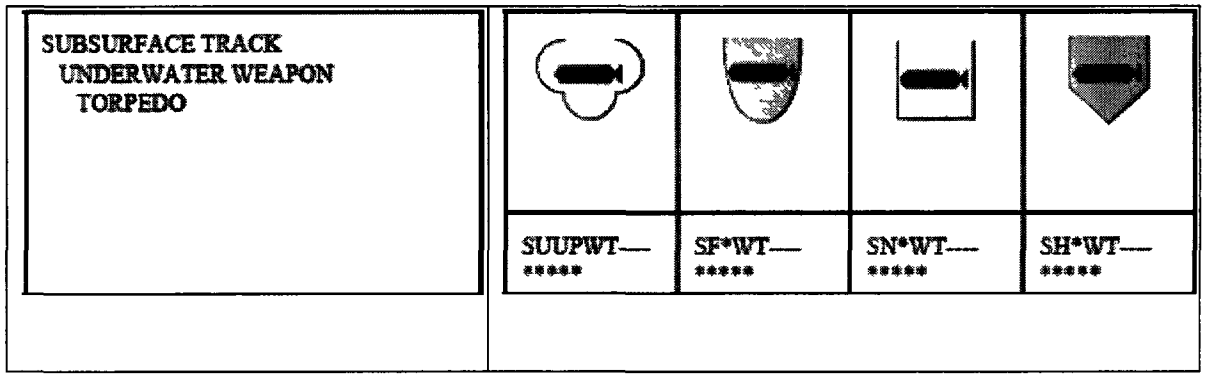

Figure 2 Subsurface Track with Torpedo Symbols (Department of Defense Interface Standard, 1999)

This information describes each element that is combined into a single symbol Hierarchy is structure for attaching symbols to universal meanings, or codes For example, an image that looks like a bow tie, whenever used within a symbol, always references a helicopter The military uses symbols to express a larger meaning through a single image Frame is whether the symbol has a line around it to frame it, if it is without a frame, or whether the frame is optional For example, the Air Track represents all aircraft regardless of service (e g Air Force, Army, Navy) and are outlined on all sides except for the bottom of the symbol whereas the Subsurface Track, including submarines, symbols are outlined on all sides except for the top of the symbol (Figure 3)

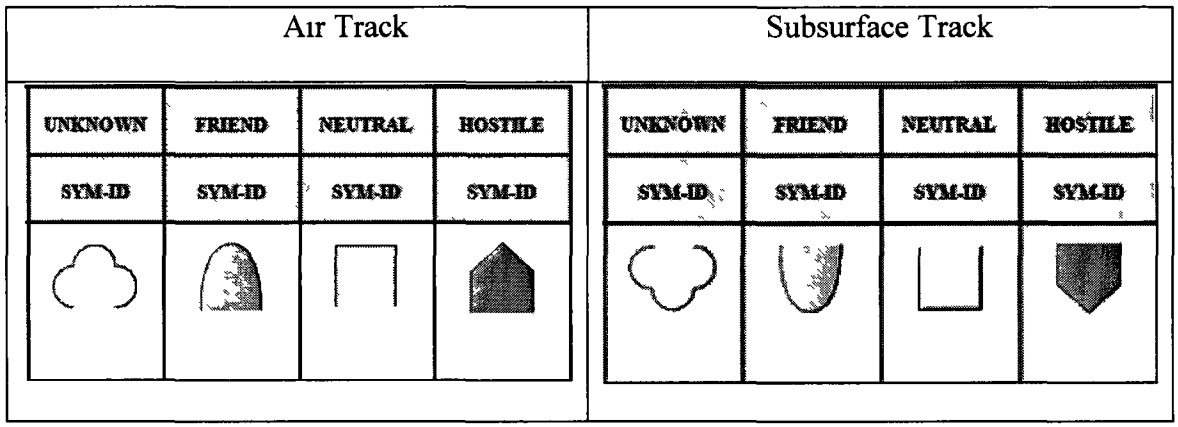

Figure 3 Air and Subsurface Symbols (Department of Defense Interface Standard, 1999)

Affiliation is the threat level represented by the object within the symbol Affiliation is made up of four categories to describe the level of offense from the warfighting object unknown, friend, neutral, and hostile (Figure 3) Hostile affiliation, for example, is in the shape of a diamond Military symbols describe tangible and intangible sensory information

Soldiers memorize these symbols, storing them in long-term memory, so that military situations are understood quickly and effectively The military uses symbols to express concepts rather than describe the concepts verbally or textually Comics provide a similar experience when readers conceptualize the images, or symbols, and understand the meaning of the symbology Not only are comics able to communicate across diverse populations because of the use of symbols that are based on image schemas, but symbol recognition is already an important part of military training Familiarity, in terms of symbol recognition, and ease of communication are advantages that comics provide when training the military

Comics have the ability to express all five senses (sight, sound, touch, taste, smell) as well as emotion, power (Schubert, 2005), time, and motion (McCloud, 1993)

McCloud (1993) demonstrates how comics can show sense of touch by discussing squiggly lines above a cup, meaning heat (steam) The sense of smell is shown through the same squiggly lines above a dog, meaning a foul smell The exact same squiggly lines have different symbolic meanings based on the surrounding images Other examples include the feeling of cold which can be shown through darts while jagged lines are used for sour tastes Jagged lines reveal anxiety and sprouting drops indicate joy There are many symbols for sensory information that remain universally understandable, this allows comics to be used for training the diverse military population

Beyond the senses, even intangible concepts such as power have universal symbols (Schubert, 2005) Power is measured spatially by vertical position, even across cultures (Fiske, 1992) The higher one resides, the more power he or she has Clichés such as *moving up the ladder* in a company imply that the higher the position, the more power one possesses The company president might have the *top* floor office of a *high-*rise building Fiske (1992) also describes the power symbol as an amount of force Amount of bodily force, which may be expressed by making a fist, relates symbolically to amount of power (Schubert, 2004) For example, the strength of a comic superhero can be shown when he or she makes a fist Power and force are intangible concepts that are recognized through symbols used in everyday society and also in comics

Time is another intangible construct that is expressed symbolically within comics The element of time can change based on the speed of motion within comic panels (McCloud, 1993) Fast moving objects seem to speed the element of time Fight scenes will often show one image per move to increase the perceived speed of each punch To

slow time, an increased number of comic panels decrease action and thereby slow motion

Harvey (1996) discusses time in comics compared to time in film Often, filmmakers show a scene in slow motion to emphasize the event In comics, the same effect happens through a number of comic panels The number of comic panels, or amount of *space*, lengthens the time necessary for the viewer to read and comprehend the scenario Space in comics is equal to time in film However, space in comics is not equal to time in comics An equal number of panels, or space per scene, creates the same emphasis for each scene, not the same amount of time For example, three panels showing a cannon ball progressing toward the reader seems to be in slow motion The same three panels with two people fighting, changing position in each panel, seem to speed up the element of time

Bongco (2000) expands the perception of time in comics by discussing the reader's eye movement across the comic panel If the reader perceives more information on a single panel, this delay relates to the timing of the story The delay creates a lagging effect for the scenario By shortening and lengthening panel sizing, time is adjusted (McCloud, 1993) Shorter panels relate to briefer amounts of time (Figure 4) and longer panels relate to lengthened amounts of time (Figure 5) With the same comic strip, the center panels in Figures 4 and 5 show how time is adjusted by panel size

Figure 4 Brief Period of Time in Center Panel *Note* From *Understanding Comics* (p 100), by Scott McCloud, 1993, New York, NY HarperCollins Publishers Copyright 1993 by Scott McCloud Reprinted with permission

Figure 5 Lengthened Period of Time in Center Panel *Note* From *Understanding Comics* (p 101), by Scott McCloud, 1993, New York, NY HarperCollins Publishers Copyright 1993 by Scott McCloud Reprinted with permission

The direction of comic panels (vertical or horizontal) also influences our perception of time McCloud (1993) points out that in western cultures, we read left to right and up to down Comic authors can rely on these conventions to manipulate our reading experience For example, cars might explode outside of horizontal panels to show speed Vertical panels can be used to slow time when something is falling A

circle of panels shows continuity Not only is the information within the panels important, but so is panel arrangement Time, space, and motion form a connected thread throughout comics that is enhanced by many universal symbolic elements

Humans often attach symbols of objects, emotions, concepts, time, motion, and other experiences to image schemas Image schemas, in return, help us to understand the symbols It is the repetition of experience with image schemas, and image schemas with experience that refines the connection and eventual metaphor, or recycled symbol This 'conscious' experience with 'unconscious' mental processing is an endless symbol formation cycle called the transcendent function (Jung, 1939) Symbols are created, reused, and remain understandable from generation to generation Comics utilize symbols to communicate across populations and also remain understandable across time because the symbols, and image schemas, do not change

Because symbol formation within individuals and societies relies on the connection between image schemas and experiences, the development of experiences becomes the focal point for understanding symbols within comics Sensorimotor contingencies develop the visual experiences that are attached to visual symbols (Noe & O'Regan, 2002), such as symbols in comics The way that comic readers visually experience their natural environment, through sensorimotor contingencies, has a universal foundation—innate image schemas Comics use symbols to exploit certain visual experiences stored in readers' knowledge that are all based on the same set of rules, or image schemas Readers and comic artists have a common understanding of symbols because of a common process of mental and sensorimotor functioning Thus, symbols become an easy way to communicate, time and again

Eisner (1985) discussed how the repetition of images and familiar symbols develops into a sort of language within comics The repetition of images and symbols becomes a 'commonality of experience' or mental images in both the comic artist and reader's memory which is necessary for the reader's comprehension of the imagery (Eisner, 1985) The comic artist communicates visually through experiences that are familiar to both the artist and reader The more easily a universal symbol is recognized and understood, the more successful the communication

In summary, symbols are powerfully effective and efficient because they are universally used and reused Comics utilize symbols to communicate quickly and easily In doing so, comics have the potential to appeal to a wide demographic and can be used to depict a variety of tasks Comics may be the epitome of communication for cognitive training in dangerous environments such as those faced by the military because of comics' ability to transfer clear and concise information through symbols

Military Decision Making and Comics

As an example of military decision makers, submariners often deal with incomplete and unreliable information due to encryption, old technology, or data noise (Kirschenbaum, 2001) For such personnel, making expert decisions rapidly is critical for survival

There are three decision making schema stages schema selection, instantiation, and action (VanLehn, 1989) Schema selection is a type or description of a problem For submariners, the schema selection is already defined as the target such as an enemy ship, there is little need for diagnostics to determine the problem type because it is usually specified by central command personnel Schema instantiation is a process of attaching

values to target traits In a battle situation, this means that values are attached to enemy ship traits Traits are parts, or information pieces, that make up the target For each trait, bits of information (values) are added to better understand the target and potential action Once instantiation is complete, the final action is the decision execution In this stage, submariners follow higher commanders' direct orders

Kirschenbaum (2001) states that the second phase in the decision making process, schema instantiation, is most important to submariners When bits of information are located and then attached to the target, certain cues are useful while others are disregarded Recognition and distinction among cues is a central process in the NDM approach (Fallesen & Pounds, 2001) Cue recognition and distinction encourages expert strategizing skills for both the Navy and the Army

The Army refers to a similar three-stage process of decision making called the hourglass model (Serfaty, MacMillan, Entin & Entin, 1997) The three stages are recognition, exploration, and matching Recognition is the formation of a schema for the current situation with progressive analysis, such as using experience and information gathering, to develop potential solutions Exploration is the analysis of the current situation and the initial plan that has been developed Computers and other planning tools may be used to help with exploration analysis Matching is the developed plan's feasibility, flexibility, and effectiveness for the current mission Possible courses of action (COAs) help expert commanders focus on critical cues within potential situations to ensure mission requirements are met

Serfaty et al (1997) discussed how expert commanders are better able to incorporate multiple angles to visualize situations, act under uncertainty, and develop

tactical plans than novice commanders Expert commanders are also more proficient at developing compromises to initial plans The two major differences between expert and novice commanders were the inclusion of plan contingencies by experts and the potential changes in the plan that were previously accounted for in the expert commanders' COA

Army commanders generate largely detailed plans early in the recognition phase and taper off their analysis in the exploration phase, finally analyzing the plan against mission needs (matching) as described in the hourglass model Submariners, however, seem to have the inverse of the hourglass three-phase process, the bulk of analysis occurs in the second phase rather than the first or third (Kirschenbaum, 2001) For both the Navy and Army, NDM facilitates an understanding of expert decision making processes Training novices to make expert decisions for the military in general requires practice

Van Den Bosch and De Beer (2003) identified five practice elements that trainees need to learn expert strategies (in addition to the three elements of expert cognitive training previously discussed) story building, testing, evaluation, time, and ambiguity

In the current study, comics were used as the medium of practice, and these five elements were expressed through the combination of comic imagery and text The story was built throughout the comic strip All assumptions, uncertainties, and past, present, and future information were made explicitly available to the trainee (Van Den Bosch & De Beer, 2003) Presenting relevant information should help trainees develop a more connected vision of the environment rather than focusing on individual elements or circumstances Trainees were tested by locating missing or contradictory information within the story They can do this through previous knowledge, assumptions, or conflict

resolution Evaluation included the assessment of the story for credibility This step was accomplished by military SMEs prior to participant involvement

The fourth practice element, time, is an added stressor in critical situations (Van Den Bosch & De Beer, 2003) Time management is an essential component of expert decision making The balance between accurate decisions and time available must be weighed carefully to avoid unwanted consequences Finally, ambiguity helps trainees recognize different possibilities for scenarios Rather than accepting information provided, trainees were encouraged to evaluate alternative decisions Overall, Van Den Bosch and De Beer's (2003) recommendations and the NDM approach (Klein, 1997) were followed in the current study and have been connected with theories such as the Sensorimotor Contingency Theory (Noe & O'Regan, 2002) and image schema (Mandler, 1992) to show the benefits of and provide justification for comics as an alternative cognitive training medium

Goals of this Research

The goal of the current study is to examine the use of comics as an effective and efficient training medium for decision making by submariners in time restricted, complex, risky situations (Klein, 2008) The current study task directions were written so that participants' performed as quickly and accurately as possible, but participants' performance time was not restricted Also, the scenarios that participants viewed expressed danger, or risk, but participants were not placed in a risky situation By incorporating Van Den Bosch and De Beer's (2003) five practice elements for expert strategies, comics are proposed as a usable, effective, and efficient alternative to current training media The intent of the comics is to create ease of learning by mapping

symbols onto mentally stored visual experiences (Paas, Renkl, & Sweller, 2003), connected to image schema (Mandler, 1992), developed through sensorimotor contingencies (Noe & O'Regan, 2002) Because the nature of submariner training is highly dynamic and complex, communication through text within the comic panels was used where necessary so that the training message was not lost

CHAPTER 2

EXPERIMENT 1

Experiment 1 Hypothesis

Comics versus Text Drawing support from a variety of perceptual and cognitive research areas and mechanisms such as Treisman's (1986) pre-attentive mechanisms, interactive mental processes (Kimchi & Hadad, 2002), Cognitive Load Theory (Paas et al , 2003), schemas (Zsambok, 1997), image schemas (Mandler, 1992), symbol development (Jung, 1939), the Naturalistic Decision Making framework (Klein, 2008), and the Sensorimotor Contingency Theory (Noe & O'Regan, 2002), the potential for cognitive training of expert decision making using comics has shown promise Given the elements of Sensorimotor Contingency Theory, it was expected that training decision makers with comics would result in quicker, more accurate, and better quality decisions because perceived comic symbols are mentally connected to present and anticipated experiential knowledge formed by sensorimotor contingencies (Noe & O'Regan, 2002) Thus, participants should not have to spend as much time or effort to interpret symbols within comics as they would to interpret text-based media

CHAPTER 3

EXPERIMENT 1 METHOD

Design

The Independent Variable (IV) was the type of training media The IV had two levels (comic media or text-based media) and was manipulated between groups Text-based media consisted of written descriptions without pictures The Dependent Variables (DVs) were speed and feasibility of responses Speed to answer each question in seconds and total time taken to answer all questions were recorded Acceptability of decisions generated was marked as correct or incorrect A one-tailed t-test was performed to assess the statistical difference of performance, speed, and view time between comic and text training

Task Overview

Two unfamiliar decision making scenarios (Appendix A) were developed, rather than one scenario, so that Experiments 1 and 2 could be performed for each participant The scenarios were developed by the researcher and both scenarios were approved by subject matter experts (Navy submarine captain and officer) to use for the study The researcher developed scenarios for Experiments 1 and 2, based on the novel, *Blind Man's Bluff* (Sontag & Drew, 1998) The two scenarios were familiar enough to participants so that the context of each comic panel was understood The scenarios were described visually through comic panels for Experiments 1 and 2 (Appendix B) The submarine officers' review and approval of comic panels were designed to have ensured participant comprehension However, participants were not able to predict the final outcome of the comic strip or outcomes during decision making tasks Each comic panel was intended to

provide enough information to allow participants to make a decision under a condition of some uncertainty Participants' decisions were based on incomplete and problematic situations for the purpose of expert decision making training

Participants

The sample was composed of entry-level submarine officers, rank O-1 Ensign, to O-4 Commanders in the U S Navy as of the summer semester of 2010 Participation by higher ranked (O-5 and O-6) officers could have skewed results due to prior training experiences within the Prospective Executive Officer (PXO) pipeline for advanced tactical training Therefore, participation was restricted to personnel at or below the O-4 level

Forty participants completed the study All participants were male and their ages ranged from 18-69, with the average age range from 30-39 Age ranges, rather than a specific age, per participant were provided The participants did not receive any compensation for participating in the study The military experts and participants were available for a limited time due to military transfers, out to sea duties, and work orders Accordingly, the researcher ran both Experiments 1 and 2 at the same time to maximize the amount of data retrieved at the times in which military members were available All APA ethical guidelines were followed Power analysis procedures for Experiment 1 are discussed below

In Experiment 1, the method used for statistical power analysis included four variables significance criterion (α), a population effect size estimate (ES), statistical power desired, and sample size (N) (Cohen, 1992) In the current study, an alpha level of 10, a large effect size, and power estimate of 80 determined the sample size A large

effect size was chosen for this study due to the homogeneity of the population and the novelty of the research Given this information, the required sample size for each group of the study was 20 participants

Materials

A professional comic artist was hired to design the submarine scenarios (Appendix A) visually through a comic strip (Appendix B) All comic strips were designed in black and white to reduce production costs and to eliminate the influence of color as an extraneous variable Text was included in comic panels where necessary, at the comic artist's discretion and SMEs' approval However, comic text (text shown within comic panels, such as talk bubbles) did not exceed half of the full text-based scenario word count With at least half as many words, the comic media was quantifiably distinct from the text-based media

An Informed Consent Form waiver (Appendix C), as required by the U S Navy's Bureau of Medicine and Surgery to protect the identity of participating submarine officers, was approved by ODU's Institutional Review Board and an informed consent form was not included in this study

A General Information Sheet (Appendix D) and Instruction Sheet (Appendix E) were provided prior to the task These sheets explained the task instructions and included spaces for entry of general participant information such as age, rank, number of years served in the military, and number of years served while working on a submarine This general information was useful when interpreting comparisons of various experience levels and decision making abilities

The Decision Sheet (Appendix F) included a number of questions that referred to the critical-thinking training process and outcome All questions were derived from items recommended by Van Den Bosch and De Beer (2003) Training process questions included information processing and argumentation In these sections, questions focused on participants' ability to recall available information, comprehend the scenario, locate unavailable, but pertinent, information within the scenario, and assess their assumptions about the scenario

Van Den Bosch and De Beer's (2003) training outcomes included results and contingency plans To further assess training outcomes, participants' decision making responses on the Decision Sheet were evaluated for feasibility of responses, time taken per question, and total time taken to complete the training

The Debriefing Sheet (Appendix G) briefly described the purpose of the study, the researcher's anticipated results, and potential benefits of comics as an alternative cognitive training medium

The participants' critical-thinking training processes and outcomes (Van Den Bosch & De Beer, 2003), or their test answers, were measured once at the end of the comic strip All participant Decision Sheet responses were graded by indicating the feasibility of responses

A grading rubric for all questions and scenarios was developed by the researcher and a submarine officer (Appendix I) The researcher and submarine officer developed several potential correct answers for each decision question, though the number of potential correct answers varied depending on the question and scenario To calculate the highest number of potential correct answers per participant, the mean of all answers was

calculated The mean was calculated by adding all eight potential correct answers for scenarios 1 and 2 and dividing by 16 questions, totaling 15 625 potential correct answers The 15 625 points was the maximum number of points achievable per participant for each scenario

The grading rubric was approved by a submarine commander Using that rubric, decisions made were marked either correct or incorrect Participant responses were graded and later evaluated along with participant's time per response and overall response time

For misleading questions that requested a "Yes" or "No" answer with an explanation, points were given to participants who responded positively and explained their answer This suggested that they were able to identify particular details questioned, and expanded on which details they had discovered For incomplete answers ("Yes" or "No" with no additional explanation), a half point was given for each "Yes" response but no points were given for "No" responses More points were awarded to participants who fully explained their answers beyond a "Yes" response

Procedure

The researcher recruited participants by word of mouth through the U S Navy command This procedure was also approved by the U S Navy's Bureau of Medicine and Surgery and ODU's IRB for specific recruitment procedures (Appendix H) Dissertation study information was allowed to be presented in Navy training classrooms, when available, but participants could not be tested in the classroom The researcher could also post flyers at the Navy training school to recruit submarine officers

Participants were between 18 and 69 years of age and working as a submarine officer in the U S Navy Each participant was asked to fill out the General Information Sheet (Appendix D) which requested demographic information such as age, rank, and number of months / years served while working on a submarine Procedures took place at various locations on or near the Naval Base in Pearl Harbor, Hawaii, at times convenient for individual submariners Alternatively, the option to run the experiment digitally through a website developed by the researcher at www ambernalu com was also available Members in the two training groups were fairly equivalent in terms of demographics, which will be discussed in the Results section

To begin the experiment, the researcher handed the participant the Instruction Sheet (Appendix E) Once the Instruction Sheet was read, the researcher asked the participant if the task instructions were clear Once the participant understood all instructions, the experiment continued

Next, the researcher placed the comic strip or text-based media on the table Once the participant indicated that he had read the comic strip / text-based media, or after 15 minutes passed, the decision task began The researcher placed nine Decision Sheets (Appendix F) face down with one question per sheet The researcher told the participant to turn the first question face up and begin writing When the participant was finished answering the first question, the participant turned it face down and turned the second sheet face up As the participant turned each question sheet face down, the researcher noted the time required to answer the question This procedure was repeated until the participant had answered all nine Decision Sheets

The participant was then thanked for his time and participation and was read the Debriefing Sheet (Appendix G) The experiment took approximately 30 minutes to complete

Participants who completed the experiment online clicked on a single link from a list of the following labels Scenario 1, Scenario 2, Scenario T1, Scenario T2, Scenario 1HD, Scenario 2HD, Scenario 1ND, and Scenario 2ND All scenarios listed had either a 1 or 2, corresponding to scenarios 1 or 2 (Appendix A) The T in the labels corresponded with the text-based media, HD with the half-detail (medium abstraction level) media, ND with the no detail (high abstraction level) media, and the numbers alone linked to the fully detailed comic media Participants who chose media from Experiment 1 (fully detailed comics or text-based media) were shown media from Experiment 2 in the second part of the study Participants who chose Experiment 2 media were shown media from Experiment 1 in the second portion of the study The Statistical Package for the Social Sciences (SPSS), version 17, was used to analyze all data from the website In-person data was not collected due to geographical limitations, though participants were allowed the option

CHAPTER 4

EXPERIMENT 1 RESULTS

To facilitate participation by geographically distributed participants, all participants logged onto the study website to participate For statistical analyses, scenarios 1 and 2 were combined in each media group, equaling 20 participants in the text-based media group and 20 participants in the comic media group

A series of independent one-tailed t-tests were performed to analyze differences among submarine officer decision scores Independent t-test assumptions included independent observations (one observation per participant), normality of the dependent variable, and homogeneity of variance Assumptions were not violated, so the Mann-Whitney U-test for non-parametric procedures was not needed

A frequency test for Experiment 1 was performed to determine participants' demographics (see Table 1) Variables included were age, military rank, and leadership decision making training The participants' demographic information was generally homogeneous with little variability in age, rank, and experience levels (see Table 1)

Table 1

Experiment 1 Frequency Table of Demographics

Variable	n	%
Age		
18-29	17	42 5
30-39	18	45 0
40-49	3	7 5
50-59	2	5 0
60-69	0	0
Military Rank		
O-1 to O-2	8	20 0
O-3 to O-4	32	80 0
Leadership Decision Making Training		
Yes	35	87 5
No	5	12 5

Note $N = 40$

A descriptives test was performed to determine the mean, standard deviation, skewness, and kurtosis of each question on the General Information form (see Table 2) Number of months / years working as a division officer and/or department head was positively skewed (2 51) and leptokurtic (7 92)

There were no significant correlations between performance accuracy and the following eight demographic variables age (p= 57), rank (p= 86), decision making training (p= 96), commissioning date (p= 88), military leadership role (p= 72), time on a submarine (p= 17), time as a division officer (p= 59), and length of leadership training (p= 37)

Table 2

Experiment 1 Descriptive Table of Participant Characteristics

Characteristic	N	*M*	*SD*	Skewness	Kurtosis
Commissioned Years (as of 1/11/2011)	40	8 81	5 09	93	36
Leadership (months)	40	87 28	57 04	1 12	78
Sub (months)	40	52 15	32 83	53	- 78
Division (months)	40	51 53	41 47	2 51	7 92
Training (months)	35	26 86	24 30	42	-1 49

An alpha of p = 10 was used instead of 05 due to the novelty of the experimental investigation Because there was a directional hypothesis, a one-tailed t-test was performed Performance, speed, and view time scores were transformed by taking the log of each score to achieve normal curves, as per the significant Shapiro-Wilk W test, thereby meeting t-test assumptions Because the log of a number less than one is undefined and the minimum performance score was 75, 25 was added to each score to move the minimum score to 1 0 prior to taking the log of all scores (Osborne, 2002) All assumptions were met for the *t*-test analyses Levene's test results for decision making performance (accuracy) were non-significant (p= 26), so equal variances were assumed One-tailed t-test results, with equal variances assumed, did not indicate that participants demonstrated better decision making performance after cognitive training with comic strip media (M = 27, SD = 20) than with text-based media (M = 32, SD = 16), $t(38)$ = 83, p= 21 Confidence intervals indicated that the population mean difference between comic strip media and text-based media for decision making performance ranged from 25 to 34

Levene's test results for speed were non-significant (p= 42), so equal variances were assumed There was no difference in speed between participants in the comic group (M = 2 48, SD = 43) and those in the text group (M = 2 60, SD = 32), t(38) = 98, p= 17 Confidence intervals indicated that the population mean difference between comic strip media and text-based media for speed ranged from 2 44 to 2 64 seconds

Levene's test results for view time were non-significant (p= 61), so equal variances were assumed The time (seconds) taken by participants to view the comic media (M =2 33, SD = 16) was significantly less than the time taken to view the text-based media (M = 2 67, SD = 15), t(38) = 7 05, p< 01 Confidence intervals indicated that the population mean difference between comic strip media and text-based media for view time ranged from 2 44 to 2 56 seconds

Participant comments were categorized by the type of media (comics or text) and further divided into two categories The two categories consisted of negative and positive comments The negative comments included commentary from participants that did not enjoy parts of the study, such as the scenario presented and/or the medium viewed The positive comments included commentary from participants that enjoyed the study Positive comments reflected participants' interest in the scenarios presented and/or possibility for new training media in the military

The categorization of text-based media commentary consisted of 7 negative comments and 13 positive comments The categorization of comic media commentary consisted of 11 negative comments and 9 positive comments

After finding no significant differences between groups for performance accuracy and speed, and to demonstrate statistical equivalence between comics and traditional

training for these measures, post-hoc equivalency tests were performed following the procedure described by Snow, Reising, Barry, & Hartsock (1999) Performance accuracy was evaluated by comparing the participants' actual points with a predefined ideal number of points found on the grading sheets (Appendix I) Equivalency margins for performance scores were calculated by using the grading sheets as a measure of best possible performance Only questions 1 through 8 were included Question 9 was not included as a performance score because it was opinion based Participants were able to score a maximum of 15 625 points on each scenario (Appendix J)

Participants were graded by adding the points earned per question for a total summed score and finding the mean of the sum of scores The mean of all eight scores was each participant's final performance score

The comic media and text-based media performance scores would be considered equivalent if the difference between the two conditions was less than 10 percent of the highest possible points (Appendix J) The equivalency margins were calculated by taking the mean of the participants' actual performance scores (30), plus or minus the equivalency margin of 26 Once this was accomplished, the equivalency margins were computed to be 04 and 56 The 90% confidence intervals for comics were 20 to 35 The 90% confidence intervals for text were 26 to 38 Comics and text media means, previously stated, did not change for any of the equivalency calculations The 90% confidence intervals for performance scores, with the equivalency margins, are shown in Figure 6 below Comic and text performance scores fall within the equivalency interval and are equivalent at the 90% confidence interval, but not at the 95% confidence interval

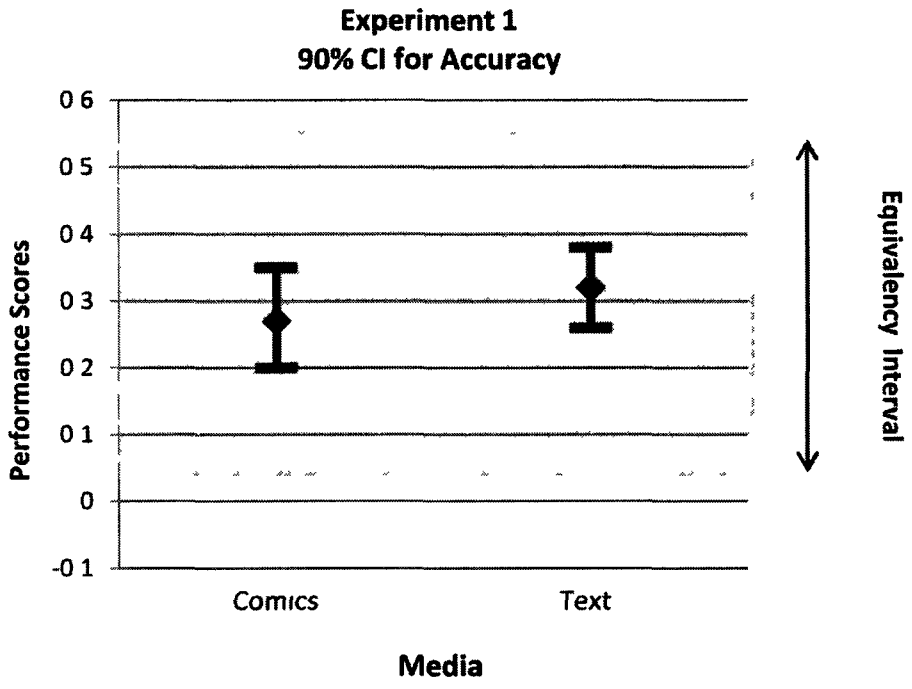

Figure 6 90% Confidence Intervals with Equivalency Margins for Performance Scores (Accuracy)

Total time to review training materials was calculated by dividing the total time allotted (30 minutes, or 1800 seconds) by 9 questions, which yielded 200 seconds per question (Appendix J) The equivalency margins were calculated by taking the mean of the participants' actual speed (2 54), plus or minus the equivalency margin of 2 2 The equivalency margins equaled 34 and 4 74 The 90% confidence intervals for comics were 2 32 to 2 65 and for text were 2 47 to 2 72 The 90% confidence intervals for speed, with the equivalency margins, are shown in Figure 7 below Comic and text speed fell within the equivalency interval and were equivalent at the 90% confidence interval

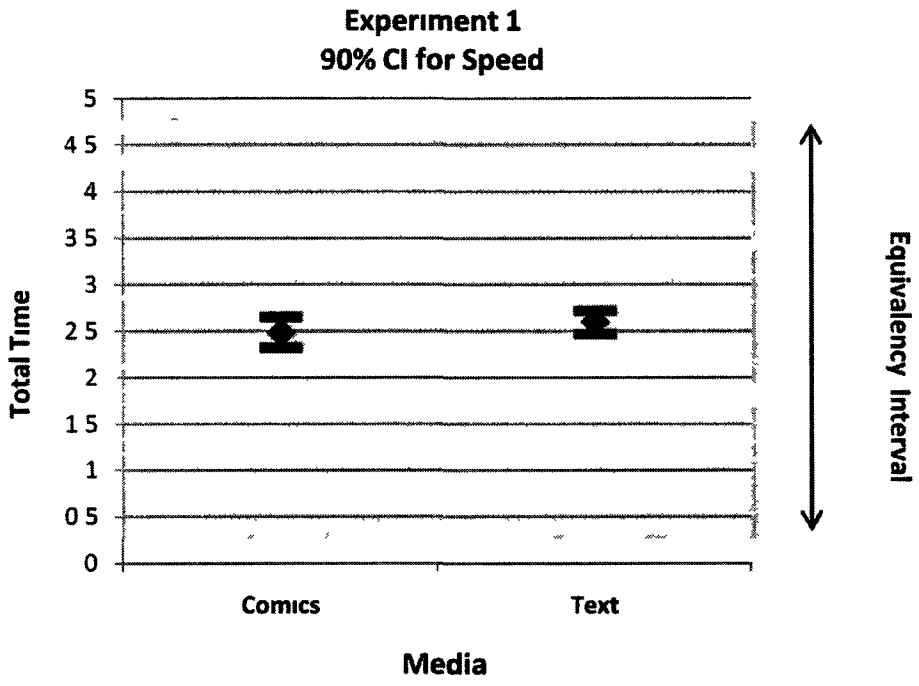

Figure 7 90% Confidence Intervals with Equivalency Margins for Total Time (Speed)

The equivalency margins for the 95% confidence intervals were calculated by taking the mean of the participants' actual speed (2 54), plus or minus the equivalency margin of 1 9 This equivalency margin was calculated by taking the log of 5 percent of the *a priori* time (1600 seconds) The equivalency margins equaled 64 and 4 44 The 95% confidence intervals for comics were 2 28 to 2 68 and for text were 2 45 to 2 75 The 95% confidence intervals for speed, with the equivalency margins, are shown in Figure 8 below Comic and text speed fall within the equivalency interval and are equivalent at the 95% confidence interval

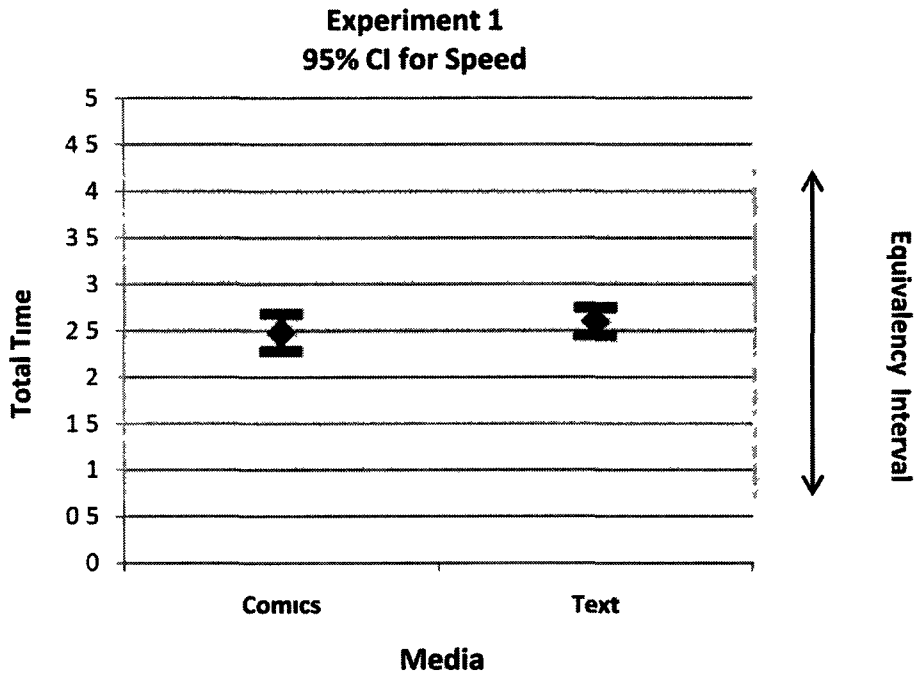

Figure 8 95% Confidence Intervals with Equivalency Margins for Total Time (Speed)

The equivalency margins for the 98% confidence intervals were calculated by taking the mean of the participants' actual speed (2 54), plus or minus the equivalency margin of 1 51 This equivalency margin was calculated by taking the log of 2 percent of the *a priori* time (1600 seconds) The equivalency margins equaled 1 03 and 4 05 The 98% confidence intervals for comics were 2 24 to 2 72 and for text were 2 42 to 2 78 The 98% confidence intervals for performance scores, with the equivalency margins, are shown in Figure 9 below Comic and text performance scores fall within the equivalency interval and are equivalent at the 98% confidence interval

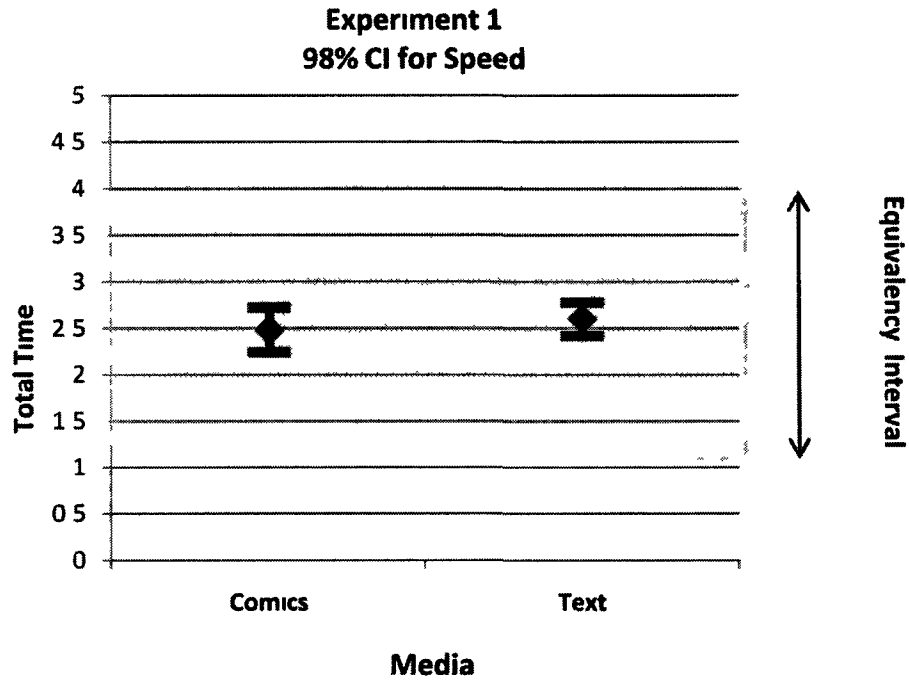

Figure 9 98% Confidence Intervals with Equivalency Margins for Total Time (Speed)

CHAPTER 5

EXPERIMENT 1 DISCUSSION

The results will be discussed in the order that they were presented in the Results section. All demographic results were normally distributed, except for the skewed and leptokurtic results for experience as a division officer. This could be due to the high level of experience by the five submarine officers aged 40 and older relative to the younger participants as shown in the frequency table (Table 1). The skewed and leptokurtic demographic results did not seem to affect the performance, speed, or view time scores.

Though participants did not demonstrate better decision making skills or increased speed after cognitive training through comic strip media than text-based media in Experiment 1, there are many pertinent explanations for this phenomenon. Perhaps results were not significant because participants were provided too much time to view the media. Significant results might have been possible if the time to view the media was restricted to better show the benefits of comic media, such as quickly understanding and retaining symbolic imagery. By viewing simplified information such as comics, cognitive load would be reduced (Mayer & Chandler, 2001) and could facilitate retention of learned information (Moreno, 2007). Restricting the viewing time might have shown how much information participants were able to quickly understand prior to answering decision making questions. In fact, this was supported by the effect of viewing time.

Significant differences for the time taken to view media (view time) were found between the comic media and text based media. This result indicated that participants took longer to interpret text than comics. Overall, participants more easily connected the comic media to image schemas (Mandler, 1992) in long term memory and were more

than twice as fast as those in the text based media group This result may suggest that the military could benefit from judicious implementation of comic training Results can be further explained, in part, by the participants' individual opinions of the comics and text presented to them

Participant Comments – Content Analysis

Participants were asked to comment about the media viewed Participant comments shed light on their impressions of the media and allowed the researcher to better understand a few of the necessary elements when training submarine officers, and possibly even other branches of the military

Positive comments for the comic media were helpful for understanding the benefits of comic media for training One participant wrote, "I think it conveyed a lot of information very quickly " Another participant wrote that it was easier to comprehend the ideas and emotions related to the situation with comics than with just words alone These comments support Mandler's (1992) theory in that comic symbolic imagery connects with image schemas and reduces cognitive load (Mayer & Chandler, 2001) These comments also reveal the participants' appreciation for comics as a novel training medium Participants intuitively understood that a positive cognitive impact, such as the reduction in cognitive load, occurred by viewing comics (Mayer & Chandler, 2001) These participant comments are valuable as a demonstration of the face validity of the scenario vignettes

Understanding participants' comments and perspectives of the comics has allowed the researcher to distinguish minor issues and positive points within the comics A minor issue in the comics was the uniforms on the characters Submariners wear blue

coveralls while out to sea The uniforms drawn in the comics were submarine uniforms worn at special events Although removing such detail from the comics may have yielded a more realistic image of the submarine crew while out to sea, it was not an important feature of the training scenario, nor was it important for participants' expert decision making in the current study

The uniforms could have been mistakenly drawn because of the researcher and comic artist's minimal military experience The comic was organized by an outline of important elements from the original scenario by the comic artist and researcher, though neither were experienced military members Although the comics were approved by military members, these members did not have experience in designing comics It would have been optimal to have all members integrated with the military so that even the slightest mishaps could be removed Nonetheless, it is doubtful that failure to do so impacted the results

The non-significant t-test results in the current study could be due to the participants' knowledge of the scenarios prior to the study Two participants wrote that they were familiar with the novel, *Blind Man's Bluff* (Sontag & Drew, 1998) Familiarity with the novel could have impacted other participants' performance scores, though they did not comment about their knowledge of the scenarios Because the scenarios were taken from an unclassified novel, participants could have had access to the scenarios prior to the study The researcher, however, does not believe that this impacted the study negatively because the two participants that were familiar with the novel did not perform better than other participants

The two participants that were familiar with the novel had average performance scores in comparison to all other participants Also, three participants commented that they would like to know the ending of the scenario These comments indicated that these participants, and probably others, were not familiar with the novel The researcher believes that future studies should question participants' familiarity with the media in the study, however, this did not appear to affect performance scores in the current study

To avoid artistic representation issues in the future, comic artists should ideally work side-by-side with a military consultant For example, an enlisted sailor who draws comics would not necessarily understand the expert decision making necessary for an officer role However, a submarine officer or commander would have sufficient knowledge of the critical cues necessary to develop comic training materials Along these lines, the optimal combination for military training through a comic medium would be a military comic artist teamed with a military psychologist Through this team, the military comic artist would understand the needs of the military members in terms of symbolism and comic imagery, whereas the military psychologist would understand how the military members would be impacted in terms of learning, cognitive load, and performance measures Both team members should be intimately involved with military cues, so to avoid any misinformation

Examination of Decision Sheet Questions

Closer examination of the Decision Sheet questions revealed issues when scoring participants' answers Although eight of the nine questions were based on previous research (Van Den Bosch & De Beer, 2003), some questions were somewhat misleading and should be discussed In question 2, "Can you detect any incomplete or contradictory

information? (please explain)," eight of the forty participants did not explain their answers These participants answered the question appropriately with either a "Yes" or "No" expressing that they could or could not detect the information but did not believe that an explanation was further necessary since the question was answered

Incomplete / contradictory information could not be resolved from other answers that the participants wrote because six of the eight participants did not provide answers for any other questions that referred to the incomplete or contradictory information For the other two participants, their survey answers were not direct in identifying the incomplete or contradictory information, but more so reported or asked questions about the events within the scenario For the two participants who provided answers in questions 4 and 5, the maximum score was one point Because their answers were fairly minimal, the incomplete / contradictory information could not be inferred for question 2 Question 2 should be reworded in such a way that participants understand that the researcher is asking them to identify and discuss particular points of discrepancy in the scenario, rather than whether or not they can, or are able to, identify discrepancies

Question 4, "What could be happening with the incomplete or contradictory information you've discovered? (please explain)," should also be discussed One-quarter of the participants did not answer the question with an explanation, or wrote that they did not understand what the question referred to This question refers to a previous question (number 2) that was somewhat misunderstood This link between questions could be an explanation for participants' short answers This question could have been placed directly after number 2 to better clarify which ideas were being referenced

A similar situation occurred for question 5, "Are there alternative explanations for the incomplete or contradictory information? (please explain)" This question referred to the previous two questions, and approximately one-third of the participants were not able to provide a full explanation in their answers Participants who responded with "Yes" received a half point because they were able to identify inconsistencies even though the details about the inconsistencies were not written There were three decision questions that were somewhat misleading, however, it did not seem to affect participants' performance, as will be discussed in the Post-hoc Equivalency Tests section All other Decision Sheet questions were understandable and answered appropriately by participants

Post-hoc Equivalency Tests

Initially, the comics and text-based media were not found to be significantly different But the question remained as to whether they were statistically equivalent Post-hoc analyses were performed to measure the equivalency of accuracy and speed between the two media groups The comics and text-based media groups' accuracies were equivalent at the 90% confidence intervals This finding indicates that the submarine officers could likely use comics as an alternative or a supplement to text when training expert decision making This finding also supports Mandler's (1992) theory in that comic symbolic imagery connects with image schemas and reduces cognitive load (Mayer & Chandler, 2001) Adding comics to the various media in use for submarine officers' training could expand their ability to train more effectively and efficiently when text and other media are not readily available or when time constraints prevent their expeditious use

The equivalency tests for answer speed showed equivalence at the 98% confidence intervals This finding indicates that the amount of time that each participant took to answer questions, whether in the comics or text-based media group, were equivalent Participants needed the same amount of time to perform, regardless of the medium viewed, and ultimately performed the same This study suggests that submarine officers could use comics to train expert decision making without requiring much additional time to train The findings are also a good example of future training possibilities for other branches of the military, such as the Army

Will Eisner's (1985) comics were used in the Army for more than 20 years This study confirms that his approach may be generalized for modern training needs The current results show promise for comic media training materials in areas other than expert decision making, just as Eisner designed

Participant Comments - Equivalency

Participant comments show that media content between groups was equivalent One participant stated that the comics, " present little of the Captain's thought processes and other pertinent data " Because the participant was not provided enough information about the captain's thought processes while engaged in a critical situation in the scenario, the participant had difficulty answering the questions at the end of the scenario in terms of what he would do if he were the captain This, however, was the case for the text-based media as well The text and comics did not reveal the captain's thoughts so that the participants could determine their own survival methods during training This comment shows the similarities of the media groups in terms of context, while keeping the media, comics versus text, independent of one another With separate

media groups, the participants performed equally and their comments support the level of difficulty in terms of context, not media

Four of the 14 participants found the flow of the comic somewhat confusing Participants' confusion is shown by the following comment "The comic was very jumpy with the timeline " Comic flow importance is better understood by McCloud's comic theory

McCloud (1993) points out that people in western cultures, such as the current study participants, read left to right and up to down This convention should be emphasized in one direction or the other, rather than both McCloud (1993) also indicates that other directions for reading comic panels can be used, but that the direction should be purposeful For example, if the panels are in a circle, then continuity within the panels should be shown In another way, if cars explode horizontally out of panels, then the purpose of the imagery is to show speed In the current study, the comic flow is an important point to examine, though few of the participants were shown to be affected by this minor issue

In terms of cognitive theory, Paas et al (2003) indicated that cognitive load, or the demands on the capacity of working memory, could be increased with training curriculum element interactivity The participants in the current study were viewing training media that had high element interactivity, meaning that the concepts had many elements that should have been mentally processed together With the participants' confusion of the comic panel layout, cognitive load increased, though their performance scores were still equivalent to the text-based media Comics are a potential alternative to

text, but perhaps comics could improve performance even more if these minor issues were removed

Theoretical Potential

By viewing training information through imagery that builds upon image schema and symbols, the comic strip group was just as able to understand the scenario and clearly develop appropriate decisions as the text-based media group Although the imagery shown within the comics and the decision questions asked are important points for discussion, they did not deter participants from performing as well as other groups

Because comics are based on symbols or simple images used to express complex concepts, lengthy text is obviated for explaining the same ideas The key, however, is determining which text should be made into symbols, and how the story should ultimately be presented in terms of text and imagery combinations Moreno's (2007) study implied that simplified animations decreased learners' cognitive load and working memory while assisting retention Comics had the same effect by assisting learners' retention of material and ultimately improving their expert decision making Results here showed that participants needed less time to connect imagery from comic media to image schemas (Mandler, 1992) than those in the text group The comics matched the participants' needs for easily communicated cues and complete situational information in less time

Information patterns matched with schemas or similar previous experiences (Zsambok, 1997) are essential to expert decision making (Klein, 2008) In Experiment 2, comic media elements for cognitive training will be examined closely by manipulating the levels of symbolic abstraction

In terms of real-world application, using comics for cognitive training has the potential to dramatically improve military expert decision making, in the same way that traditional text-based instructional methods have shown The ability for diverse populations to understand the same information in an effective and efficient manner makes comics a valuable training tool for groups such as the military

Comics could also be beneficial as a tool for classroom discussion Rather than referring to a particular paragraph or page within text-based media, the points of interest such as symbols, or critical cues, within comics could be utilized for classroom discussion because trainees' reliance on working memory would decline According to Mayer, Bove, Bryman, Mars, and Tapangco (1996) lengthy text-based explanations can overload working memory and decrease retention of learned materials The use of concise text with imagery was shown to decrease cognitive load and assist retention During classroom discussion, trainees should quickly and easily familiarize themselves with critical cues through symbols within comic media, allowing greater cognitive capacity for discussion, while instructors expand on the cue with potential issues and possible scenarios

The next step for research is to assess the impact that different image detail levels have for decision making training Different image detail levels for the same scenario might create changes in results, given that the communication of important training points through comic imagery was at the artist's creative discretion In Experiment 2, comic imagery detail was manipulated by presenting participants with different levels of symbolic abstraction

Practically, level of abstraction is important because if good training can result from highly abstract comics, then even novice artists, such as soldiers or commanders without comic art training, can effectively use the comics method On the other hand, if comic imagery must be precise to be effective, this limits the practicality of the comics method Theoretically, it is interesting because the question is one of generalization, it is an examination of how exact the images must be to trigger cognitive image schemas

CHAPTER 6

EXPERIMENT 2

Manipulation of symbolic abstraction is important because it separates highly detailed drawings from more simplistic drawings of images or symbols In Experiment 1, trained comic artists designed the images, incorporating full detail in the drawings In Experiment 2, the level of artistic detail was manipulated so that it could be examined as a causative influence on performance results

To clarify terminology, low symbolic abstraction in comics is equivalent to high fidelity of comic imagery, medium abstraction is equivalent to medium fidelity (center point between low and high fidelity), and high abstraction is equivalent to low fidelity To reduce confusion, the term "abstraction level" will be used from this point forward In Experiment 2, level of abstraction was operationalized by the number of details per image Given the tenets of Sensorimotor Contingency Theory (Noe & O'Regan, 2002), low abstraction symbols should be more readily recognizable and connected with mentally stored experiences than high abstraction symbols that are less readily recognizable

Experiment 2 Hypothesis

The researcher hypothesized that participants' performance after viewing the lower level of symbol abstraction (higher fidelity of comic imagery) within comics would be superior to the higher abstraction comics (lower fidelity of comic imagery) It was expected that participants would make quicker, more accurate, and better quality decisions when interpreting comics with a low level of symbolic abstraction Feasibility

of decisions was expected to decline while speed and view time would increase with higher levels of abstraction

Comics utilize symbols to express a variety of environments, emotions, and experiences (McCloud, 1993) According to Eisner (1985), easily recognized symbols support the successful communication between comic creators and readers In terms of cognition, the reader understands the comic symbols viewed by utilizing image schemas (Mandler, 1992) If the level of symbolic abstraction is increased, the connection between symbolic imagery and mental structures, image schemas, would be more difficult and performance would degrade

CHAPTER 7

EXPERIMENT 2 METHOD

Design

Level of symbolic abstraction, as represented through the comic strip medium, was manipulated between groups The IV had three levels of symbolic abstraction within the comic strip, which were increased or decreased based on the number of details for each symbol Details consisted of additional elements to any shape, such as eyes on a face or costume (interior details), background, or interaction with other characters and objects as shown in Figure 10 below The low level of symbolic abstraction had a fully detailed comic strip that included interior details, background, and interactions with other characters and inanimate objects for all comic panels The medium level of symbolic abstraction used the low level panels and deleted half of all interior details, background, and interactions with inanimate objects within each panel

Details were counted and exactly half were removed from each panel If an odd number of details were counted, half of one detail was removed so that all panels had an equal level of symbolic abstraction Details were not removed in any central area, but removal was accomplished throughout the image so that emotional expressiveness in characters' faces, for example, was not completely lost Interactions with other characters were not deleted to show which character was speaking, and to keep consistency throughout levels The high level of symbolic abstraction did not include any interior, background or interactions with inanimate objects and showed only the outside lines of each major part of the symbol(s), as depicted in Figure 10 Line width and text remained unchanged throughout each level A second professional comic artist judged

the credibility of the manipulation of abstraction All comic panels' levels of symbolic abstraction were discussed between the two comic artists until they reached an agreement about the optimal expression of abstraction for each level

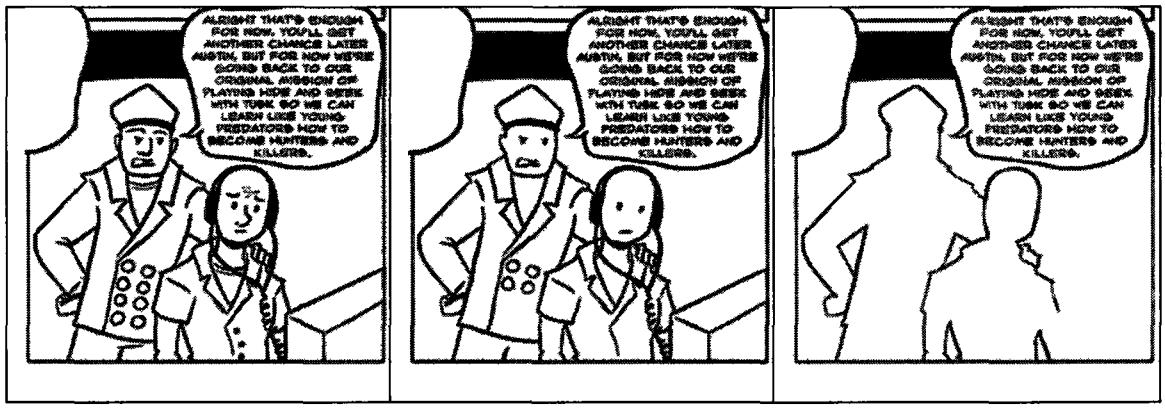

Figure 10 Comic Panels Representing Low Abstraction (Left), Medium Abstraction (Middle), and High Abstraction (Right)

As was the case during Experiment 1, military members had limited time to participate in the current study With participants examining media from both Experiments 1 and 2 during the same session, the researcher had two comic strips designed from two separate scenarios Each comic strip had three levels of symbolic abstraction Six comic strips in total were designed so that participants were not exposed to the same level of abstraction or the same comic strip in any study session (Appendix B)

The Dependent Variables (DV) included feasibility of participant responses written on the Decision Sheets, speed required to generate responses, and material viewing time Feasibility of responses was dichotomously marked as correct or incorrect

and provided a grade according to the grading sheet discussed in Experiment 1 Speed of response, calculated per question and for the entire task, was also recorded

Participants

Participant information in terms of demographics (see Appendix D), with the exception of the planned number of participants, was the same as Experiment 1, power analysis procedures are discussed below

In Experiment 2, the method used for statistical power analysis was the same as described in Experiment 1 In the current study, an alpha level of 10, a large effect size, and power estimate of 40 determined the sample size (Cohen, 1992) The power estimate of 40 was chosen as provided by Cohen's (1992), "A Power Primer," table for a one-way ANOVA Given this information, the sample size for each of the three groups in Experiment 2 required 17 participants

One-way, between-subjects ANOVA assumptions include normality of sampling distributions of means, normality of the dependent variable, independence of errors, homogeneity of variance, and absence of outliers Assumptions were not violated For this analysis, 51 participants were needed (Cohen, 1992), however, only 45 participants were tested due to recruitment challenges Overall, there were 17 participants in the low abstraction group, and 14 participants in both the medium and high abstraction groups

Because ANOVA is robust to unequal sample sizes, non-parametric analyses were not needed The one-way, between-subjects ANOVA test was used to test for a significant difference among groups on the DV

Materials

The same comic artist was hired to design the submarine scenarios (Appendix A) as in Experiment 1 The comic strip (Appendix B) was in black and white to reduce production costs Text was included in comic panels where necessary, at the comic artist's discretion and submarine captains' approval Materials, including the comic strips, were not altered between Experiments 1 and 2

The General Information Sheet (Appendix D), Instruction Sheet (Appendix E), Decision Sheet (Appendix F), Debriefing Sheet (Appendix G), the grading of participants' Decision Sheet responses (Appendix I), and the digital option for running the experiment was the same as those used in Experiment 1 Grading sheets and scoring procedures were also the same as those presented in Experiment 1 Experiments 1 and 2 were presented to participants in the same session, due to participants' time limitations, materials were not adjusted for Experiment 2

Procedure

Procedures were the same as those presented in Experiment 1, excluding the use of text-based media

CHAPTER 8

EXPERIMENT 2 RESULTS

All 45 participants in Experiment 2 completed participation using the experimental website Participant demographics and results from Experiment 1's high fidelity comic media (low abstraction group) were also compared to data in Experiment 2 New data were not obtained because of the specialized group of participants and time limitations from military duties A frequency test for experiment 2 was performed to determine participants' demographics (Table 3) Variables included were age, military rank, and leadership decision making training

Table 3

Experiment 2 Frequency Table of Demographics

Variable	n	%
Age		
18-29	20	44 4
30-39	21	46 7
40-49	3	6 7
50-59	1	2 2
60-69	0	0
Military Rank		
O-1 to O-2	4	8 9
O-3 to O-4	41	91 1
Leadership Decision Making Training		
Yes	36	80 0
No	9	20 0

Note $N = 45$

A descriptives test was performed to determine the mean, standard deviation, skewness, and kurtosis of each question (variable) on the General Information form (Table 4) The number of participants tested fell short of the planned number due to the few available submarine officers (approximately 10 or fewer) per training command per quarter

Of the five variables on the General Information form, two variables were skewed and/or kurtotic The first variable, participants' number of months / years working as a division officer and/or department head question (Division (months)), was positively skewed (2 93) and leptokurtic (14 31), similar to the results found in Experiment 1 The second variable, with regard to leadership decision making training (Training (months)), was leptokurtic (2 48) Overall, the participants' demographic information was highly homogeneous with little variance in age, rank, and experience levels

There were no significant correlations in Experiment 2 between performance accuracy and the following eight demographic variables age (p= 15), rank (p= 42), decision making training (p= 92), commissioning date (p= 91), military leadership role (p= 50), time on a submarine (p= 78), time as a division officer (p= 57), and length of leadership training (p= 54)

Table 4

Experiment 2 Descriptive Table of Participant Characteristics

Characteristic	N	*M*	*SD*	Skewness	Kurtosis
Commissioned Years (to 1/11/2011)	45	8 50	4 28	1 06	1 07
Leadership (months)	45	84 69	50 93	1 39	1 80
Sub (months)	45	48 16	26 94	90	- 03
Division (months)	45	49 91	30 44	2 93	14 31
Training (months)	36	26 14	31 56	1 61	2 48

One-way ANOVA assumptions were not violated and scores were not skewed or kurtotic Sample sizes were unequal, according to Cohen's (1992) statistical power analysis calculations Total performance scores were normally distributed as per the significant (p> 10) Shapiro-Wilk W test Performance, speed, and view time scores were transformed by taking the logarithm of each time to achieve normality Because the log of a number less than one is undefined and the minimum performance score was 375, 625 was added to each score to move the minimum score to 1 0 prior to taking the log of all scores (Osborne, 2002) All assumptions were met for the ANOVA analyses The one-way, between-subjects ANOVA was performed with a 10 p-value to assess if there was a statistical difference between expert decision making training through a comic medium among three different levels of symbolic abstraction

No significant differences were found for performance scores across the high abstraction (M= 38, SD= 14), medium abstraction (M= 39, SD= 21), and low abstraction comic media (M= 35, SD= 14), $F(2, 42)$ = 33, p= 72 Confidence intervals indicated that

the population mean difference between high, medium, and low comic media for performance ranged from 33 to 41

No significant differences were found for speed across the high abstraction (*M*=2 61, *SD*= 45), medium abstraction (*M*=2 69, *SD*= 50), and low abstraction comic media (*M*=2 45, *SD*= 42, *F*(2, 42) = 1 18, *p*= 32 Confidence intervals indicated that the population mean difference between high, medium, and low comic media for performance ranged from 2 46 to 2 69

No significant differences were found for view time across the high abstraction (*M*=2 32, *SD*= 23), medium abstraction (*M*=2 34, *SD*= 17), and low abstraction comic media (*M*=2 30, *SD*= 15), *F*(2, 42) = 21, *p*= 81 Confidence intervals indicated that the population mean difference between high, medium, and low comic media for performance ranged from 2 27 to 2 36

Participant comments were categorized by the comic abstraction level and further divided into two categories The two categories were the same as Experiment 1 that consisted of negative and positive comments The categorization of low abstraction commentary consisted of 10 negative comments and 10 positive comments The categorization of medium abstraction commentary consisted of 4 negative comments and 10 positive comments The categorization of high abstraction commentary consisted of 8 negative comments and 6 positive comments

Post-hoc equivalency tests were performed for performance scores (accuracy), total time (speed), and view time The high, medium, and low abstraction comic media performance scores would be considered equivalent if the difference between the two conditions was less than 10 percent of the highest possible points, or 15 625 (Appendix

J) The equivalency margins equaled 03 and 71 The 90% confidence intervals for high abstraction comics was 32 to 45, medium abstraction was 29 to 49, and low abstraction was 29 to 41 All comic abstraction level means, previously stated, did not change for any of the equivalency calculations The 90% confidence intervals for performance scores, with the equivalency margins, are shown in Figure 11 below All comic abstraction level performance scores fall within the equivalency interval and are equivalent at the 90% confidence interval

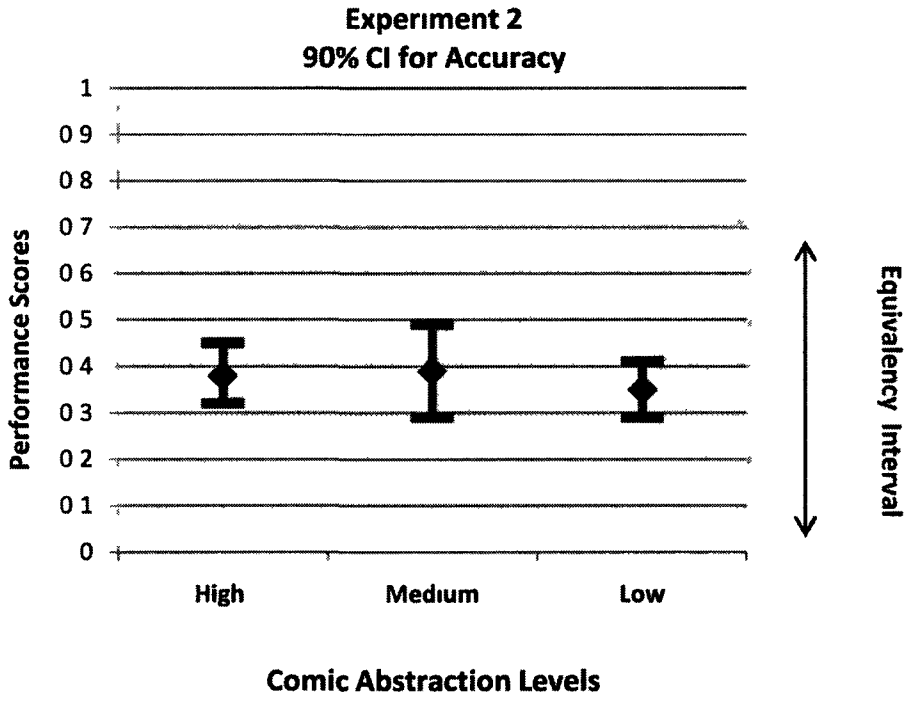

Figure 11 90% Confidence Intervals with Equivalency Margins for Performance Scores

The high, medium, and low abstraction comic media performance scores would be considered equivalent if the difference between the two conditions was less than 5 percent of the highest possible points, or 15 625 (Appendix J) The equivalency margins

equaled 22 and 52 The 95% confidence intervals for high abstraction comics was 31 to 46, medium abstraction was 27 to 52, and low abstraction was 28 to 42 The 95% confidence intervals for performance scores, with the equivalency margins, are shown in Figure 12 below All comic abstraction level performance scores fall within the equivalency interval and are equivalent at the 95% confidence interval

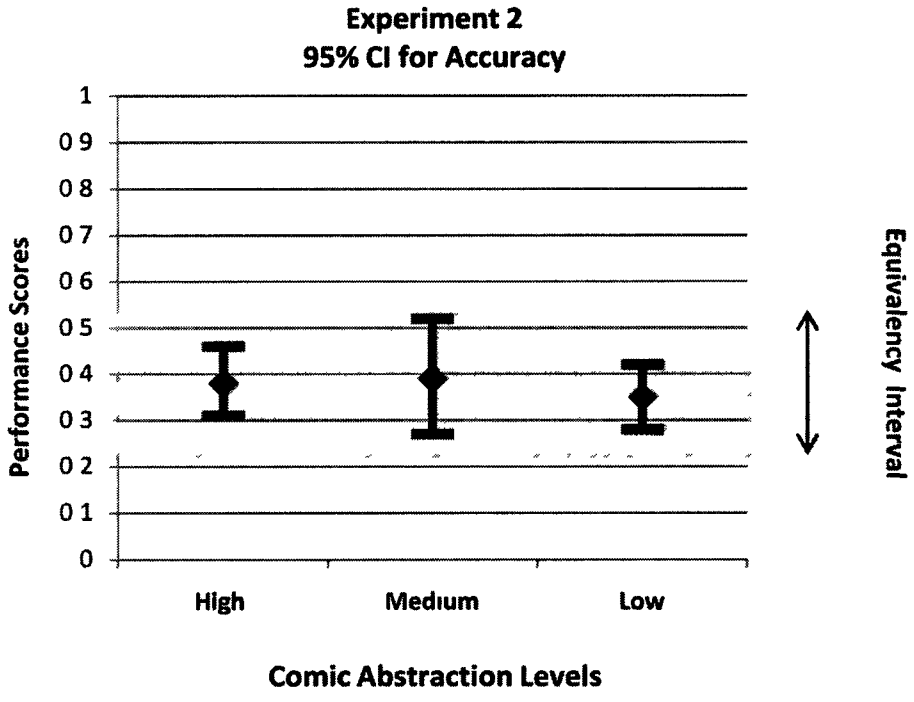

Figure 12 95% Confidence Intervals with Equivalency Margins for Performance Scores

The total time estimated for Experiment 2 was the same as Experiment 1 (30 minutes) The comic abstraction level speed would be considered equivalent if the difference between the two conditions was less than 10 percent of the *a priori* time (1600 seconds) (Appendix J)

The equivalency margins equaled 38 and 4 78 The 90% confidence intervals for high abstraction were 2 40 to 2 82, medium abstraction were 2 46 to 2 93, and low abstraction were 2 27 to 2 63 The 90% confidence intervals for speed, with the equivalency margins, are shown in Figure 13 below All comic abstraction level speed intervals fall within the equivalency interval and are equivalent at the 90% confidence interval

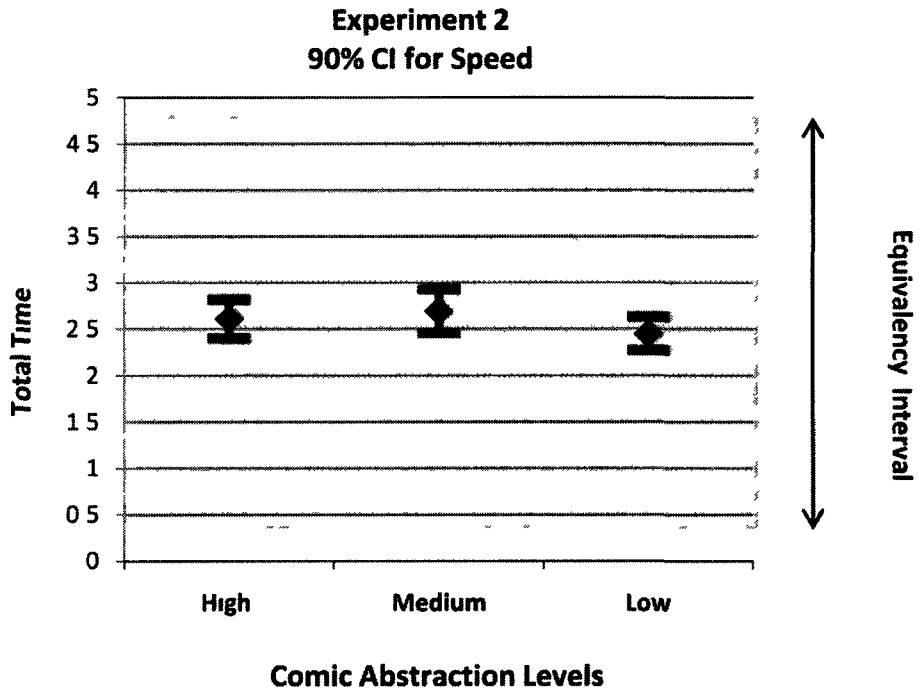

Figure 13 90% Confidence Intervals with Equivalency Margins for Speed

The equivalency margins for the 95% confidence intervals were calculated by taking the mean of the participants' actual speed (2 58), plus or minus the equivalency margin of 1 9 The equivalency margins equaled 68 and 4 48 The 95% confidence intervals for high abstraction were 2 35 to 2 86, medium abstraction were 2 41 to 2 98,

and low abstraction were 2 24 to 2 66 The 95% confidence intervals for speed, with the equivalency margins, are shown in

Figure 14 below All comic abstraction level speed intervals fall within the equivalency interval and are equivalent at the 95% confidence interval

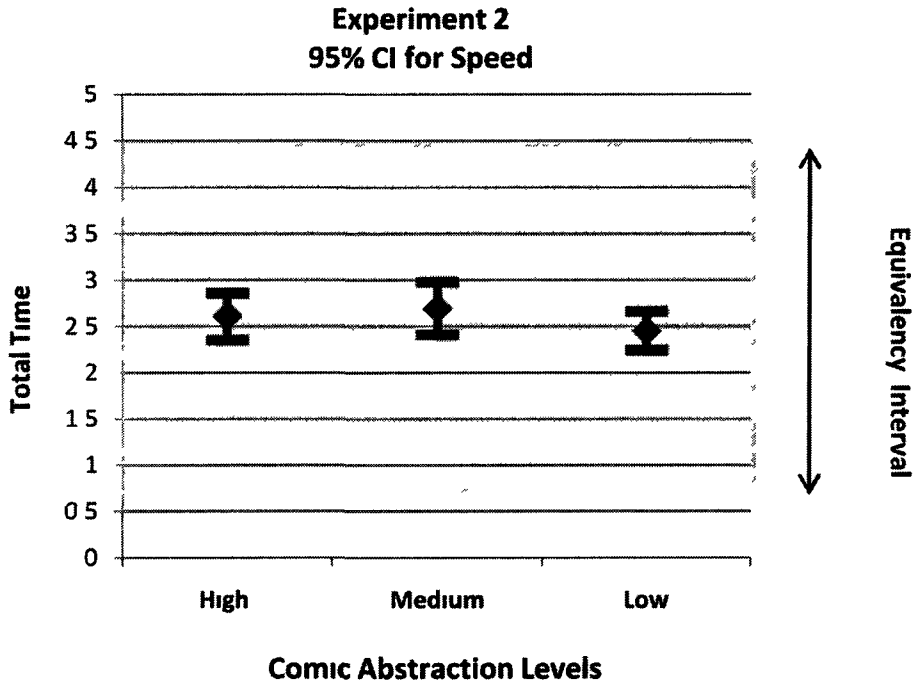

Figure 14 95% Confidence Intervals with Equivalency Margins for Speed

The equivalency margins for 98% confidence intervals were calculated by taking the mean of the participants' actual speed (2 58), plus or minus the equivalency margin of 1 51 The equivalency margins equaled 1 07 and 4 09 The 98% confidence intervals for high abstraction were 2 29 to 2 92, medium abstraction were 2 34 to 3 05, and low abstraction were 2 19 to 2 71 The 98% confidence intervals for speed, with the equivalency margins, are shown in Figure 15 below All comic abstraction level speed

intervals fall within the equivalency interval and are equivalent at the 98% confidence interval

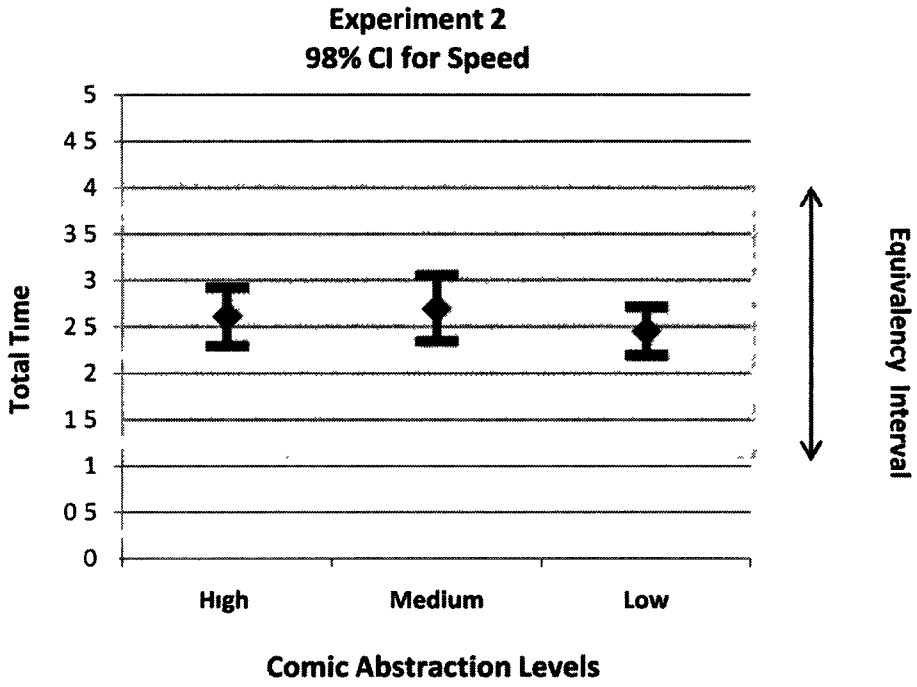

Figure 15 98% Confidence Intervals with Equivalency Margins for Speed

The total view time estimated for Experiment 2 was 15 minutes The comic abstraction level speed would be considered equivalent if the difference between the two conditions was less than 10 percent of the view time (900 seconds) (Appendix J)

The equivalency margins equaled 37 and 4 27 The 90% confidence intervals for high abstraction were 2 21 to 2 43, medium abstraction were 2 26 to 2 42, and low abstraction were 2 24 to 2 36 The 90% confidence intervals for view time, with the equivalency margins, are shown in Figure 16 below All comic abstraction level view

time intervals fall within the equivalency interval and are equivalent at the 90% confidence interval

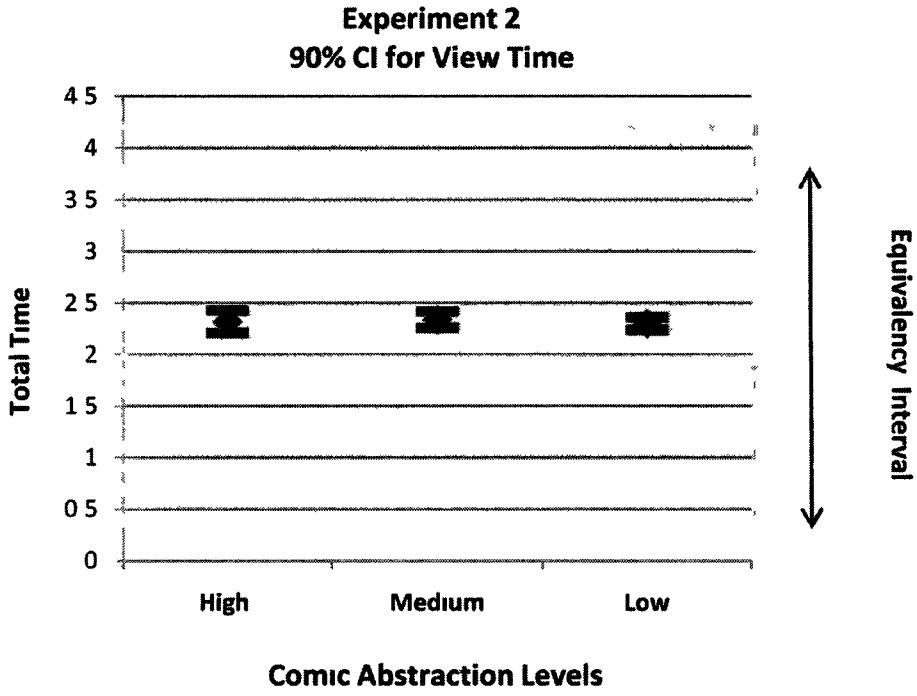

Figure 16 90% Confidence Intervals with Equivalency Margins for View Time

The equivalency margins for the 95% confidence intervals were calculated by taking the mean of the participants' actual view time (2 32), plus or minus the equivalency margin of 1 65 The equivalency margins equaled 67 and 3 97 The 95% confidence intervals for high abstraction were 2 19 to 2 45, medium abstraction were 2 24 to 2 44, and low abstraction were 2 22 to 2 37 The 95% confidence intervals for view time, with the equivalency margins, are shown in Figure 17 below All comic abstraction level view time intervals fall within the equivalency interval and are equivalent at the 95% confidence interval

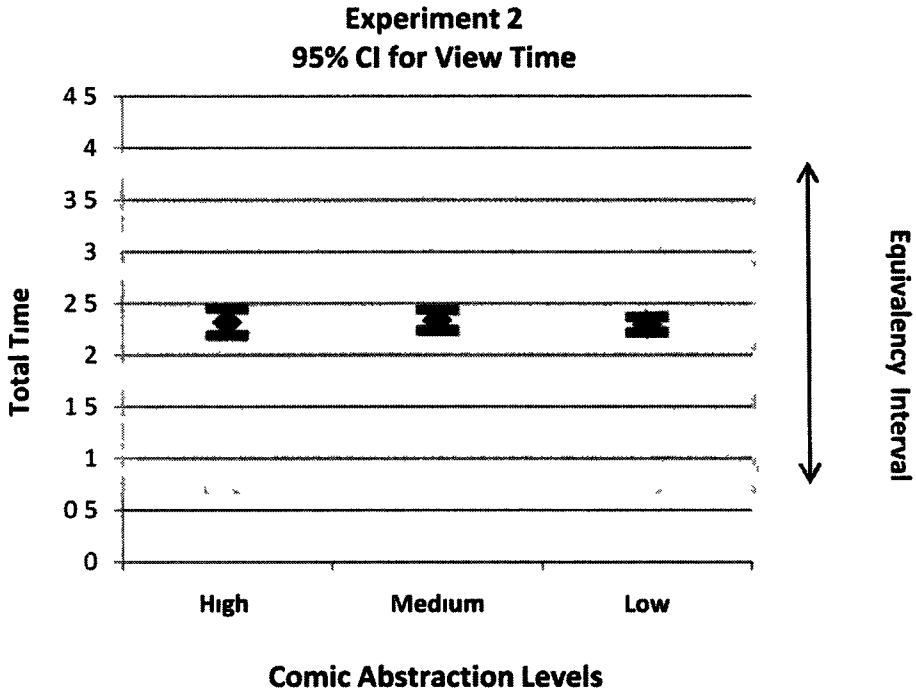

Figure 17 95% Confidence Intervals with Equivalency Margins for View Time

The equivalency margins for the 98% confidence intervals were calculated by taking the mean of the participants' actual view time (2 32), plus or minus the equivalency margin of 1 26 The equivalency margins equaled 1 06 and 3 58 The 98% confidence intervals for high abstraction were 2 16 to 2 48, medium abstraction were 2 22 to 2 46, and low abstraction were 2 21 to 2 39 The 98% confidence intervals for view time, with the equivalency margins, are shown in Figure 18 below All comic abstraction level view time intervals fall within the equivalency interval and are equivalent at the 98% confidence interval

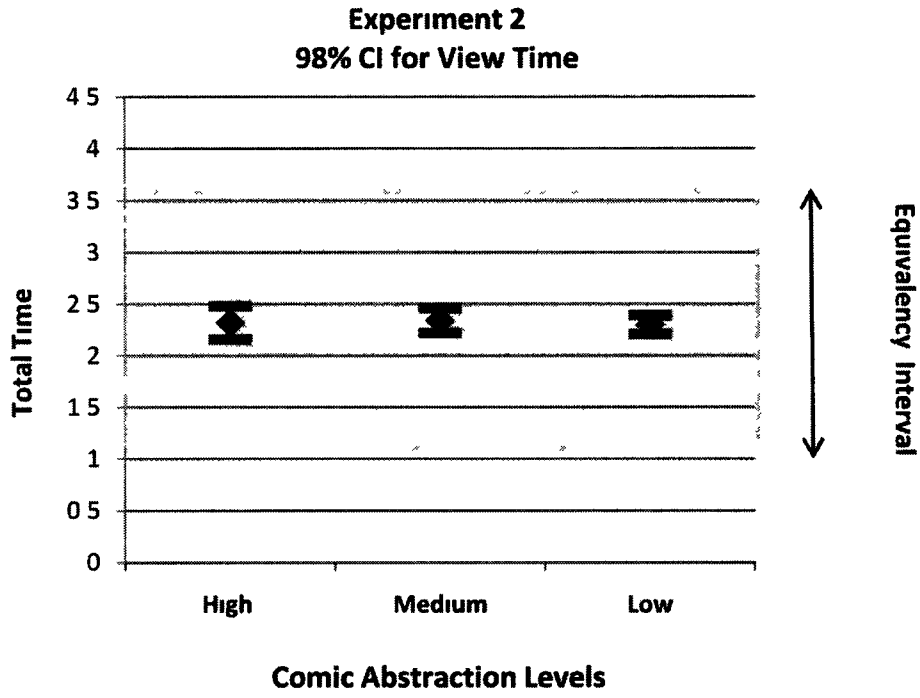

Figure 18 98% Confidence Intervals with Equivalency Margins for View Time

CHAPTER 9

EXPERIMENT 2 DISCUSSION

The Experiment 2 results will be discussed in the same order as they were written in the Results section The researcher attempted to equalize the number of participants viewing Scenarios 1 or 2 by removing links on the study website that no longer needed participant data This was successful with few difficulties since most participants were online at separate times

Observed decision making skills and speed did not differ as a function of symbolic abstraction in the comic media As with Experiment 1, these results can be explained, in part, by the participants' individual opinions of the comics presented to them Participants' preference of the low and high abstraction comics were almost evenly divided, though they generally liked the medium abstraction comic These comments could explain the non-significant performance and speed results

Participant Comments

As discussed in Experiment 1, participants were asked to comment about the comic media viewed in Experiment 2 The comments helped explain how the comic imagery was affecting participants relative to the text bubbles chosen for the comic The participant comments shed light on how the imagery affected participants' perceptions, and possibly their performance data

The even distribution of positive and negative comments in the low and high abstraction groups does not explain how the abstraction level might have affected participants' preference However, an examination of the comments for the medium abstraction level provides additional insights

The number of positive comments in the medium abstraction group more than doubled the number of negative comments This contrast between the medium abstraction group and the other abstraction groups seemed to reflect considerations of imagery shown and (more importantly) not shown

There were very few comments that reflect difficulties in the medium abstraction group, which will be discussed first Four of the 14 participants avoided the diesel submarine scenario because they could not adequately answer questions about the diesel submarine's technical capabilities to survive in the critical situation based on their current knowledge of modern nuclear submarine technical capabilities One participant wrote, " the submarine was an older ship[ ] I'm not familiar with a lot of the procedures that would be used or what plans could be effectively employed " Another participant wrote, "There were some portions that do not translate well into the modern submarining context, but overall it was a decent portrayal " The diesel submarine scenario affected participants both negatively and positively Overall, the scenario matched most participants' understanding of the submarine and its capabilities in a critical situation In the current study, Navy requirements were that all materials be unclassified, so older submarine scenarios were utilized For the few participants who questioned the capabilities of an older submarine, future studies could include a researcher that is also a military member, or that has a high enough clearance for reviewing classified materials so that information is more up-to-date Also a revision process should be in place so that materials remain up-to-date

Most participants wrote positive comments about the medium abstraction group The interesting part about their comments is that they focused on the scenario rather than

the misinformation previously discussed, such as incorrect uniforms Participants had some minor difficulties with the flow of the comic, but overall found the material interesting One participant wrote, "It was interesting to see my profession portrayed in that format " Other participants wrote, "Yes This is an excellent way of conveying lots of information quickly," and, "Yes, very interesting situation " Participants enjoyed the medium abstraction group and saw it as a viable training medium

Misinformation, as previously discussed in Experiment 1's low abstraction comic media group, was removed from the medium abstraction group Specifically, the uniform details were removed By comparing panels (Figure 19), the uniforms in the medium abstraction comic panel look more like plain t-shirts

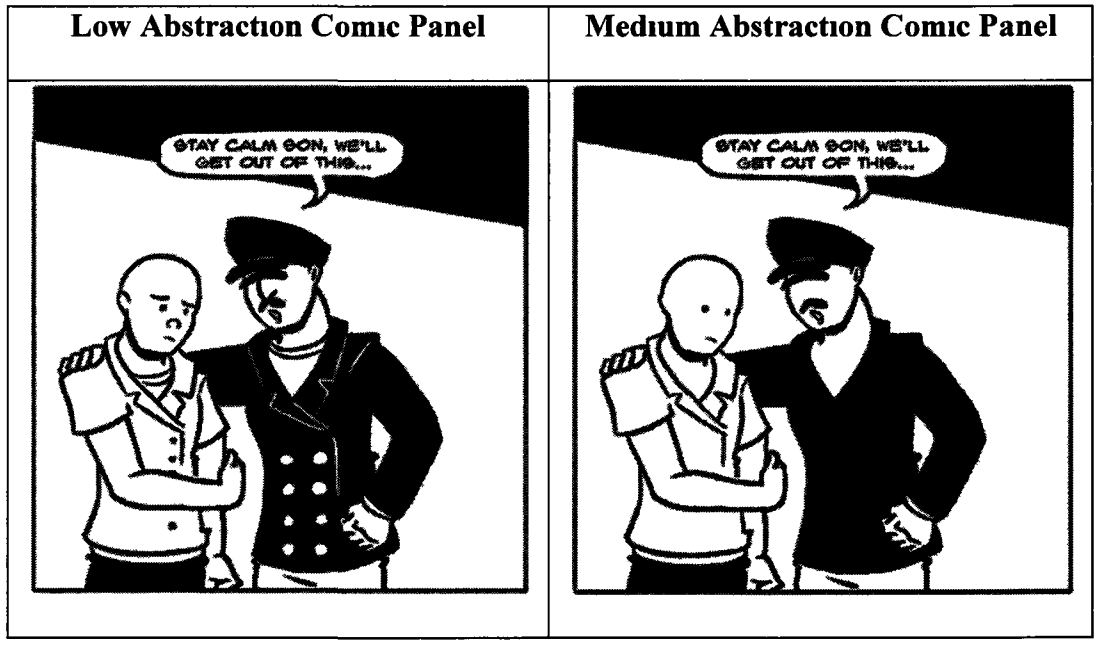

Figure 19 Comparison of the Low Abstraction Comic Panel to the Medium Abstraction Comic Panel

In the medium abstraction comic panel, the uniform pleats and buttons were removed Because of the removal of these details, the clothing became unidentifiable The captain's uniform became a dark, plain shirt, rather than a uniform With this slight misinformation removed, participants might have preferred the medium abstract comic strip more readily than the low abstraction comic strip, though their higher preference did not show differences in their performance or speed scores

In the high abstraction group, positive and negative participant perspectives of the comic strip were almost split in half Participants were most concerned with the limited details, though this did not entirely sway them either negatively or positively One participant's positive comment was, "There was less data [sic] than I would have liked, but it was interesting " Even with minimal information, participants enjoyed the comic media

The medium abstraction comic strip was most preferred and included enough detail for participants to decipher the events without removing too many details, as in the high abstraction group Even though certain levels of symbolic abstraction were preferred, their performance was not affected between abstraction levels Perhaps the format of the question was an issue in providing too little guidance when participants commented about their experience

As it was, the question "Did you like the comic" allowed participants to choose what they wanted to discuss For future studies, a suggestion would be to reword the question, such as, "Were you able to understand the flow of the comic strip?" or "Were the comic figures representative of actual characters?" to gain more specific knowledge about their experiences

Examination of Decision Sheet Questions

Examination of the Decision Sheet questions revealed similar issues discovered in Experiment 1 when scoring participants' answers Participants were somewhat misled by the same questions as in Experiment 1 because both experiments were run in the same session In question 2, "Can you detect any incomplete or contradictory information? (please explain)," just under one-seventh of the participants did not explain their answers These participants again answered the question appropriately with either "Yes" or "No," expressing that they could or could not detect the information and did not believe that further explanation was necessary Incomplete answers were graded in the same way as discussed in the *Experiment 1 Method* section Overall, the question should be reworded in such a way that participants understand that the researcher is asking them to identify and discuss particular points of discrepancy within the scenario, rather than whether or not they can, or are able to, identify discrepancies

Question 4, "What could be happening with the incomplete or contradictory information you've discovered? (please explain)," refers to the previous question (number 2) Similar to Experiment 1, just over one-quarter of the participants did not answer the question with an explanation

Question 5, "Are there alternative explanations for the incomplete or contradictory information? (please explain)," refers to the previous two questions and just over half of the participants were unable to answer it Participant responses were similar to previous questions with responses such as, "None that I can determine " Because all groups received the same questions, these minor discrepancies did not affect study

results All other Decision Sheet questions for Experiment 2 were understandable and answered appropriately by participants

With non-significant one-way ANOVA results in Experiment 2, it is seems that the imagery did not affect performance, speed, or view time Perhaps different text could have been chosen from the scenarios to tell the story through comics The remaining question is whether the imagery should be drawn by a professional comic artist, or whether an untrained person could create comic stimuli The equivalency test results reported here seem to indicate that even rudimentary comic images may be successfully used for training

Equivalency Tests

The performance scores (accuracy) were found to be equivalent at the 95% confidence intervals The total time (speed) was found to be equivalent at 98% confidence intervals The view time was also equivalent at the 98% confidence intervals Because accuracy, speed, and view time were equivalent, the results show that comic imagery can be drawn by anyone who has the knowledge necessary to include pertinent cues for the population being trained Although minor misinformation in the current study did not appear to affect participants' performance, it would be best to have training materials that are as accurate as possible to avoid any confusion Overall, a professional comic artist is great to have, but not necessary

As previously discussed in Experiment 1 Discussion section, it would be best to employ a military member who is familiar with the military cues and protocols necessary for training, as well as trainees' needs A psychologist who is intimately involved with the military cues should also be employed to assess learning and performance measures

Both members would ensure, to the best of their abilities, that misinformation is not included in training materials

Theoretical Potential

Experiment 2 findings support the use of comics with any level of symbolic abstraction to train expert decision making Cue selection (Treisman, 1986) was just as easily distinguishable and was matched to schemas in long term memory (Paas et al , 2003) in all levels perhaps because the details were unnecessary for complete comprehension

According to Mandler (1992), humans are able to fill in the missing details when viewing imagery that does not fully show all of the necessary portions of an object This study shows that participants were not affected by the imagery in Experiment 2 with different levels of symbolic abstraction The participants were sufficiently able to fill in the missing data, whether it was the medium abstraction comics with half of the detail shown, or the high abstraction comics with no details shown

Top-down processing plays an important role in the participants' ability to fill in missing details when viewing comics, as shown in each level of symbolic abstraction comics Top-down processing occurs when knowledge-based information influences perception (Noordman & Vonk, 1998) In the current study, participants viewing the comics utilized their knowledge to create a fuller image, of the comics being viewed, in their mind Without prior knowledge, participants would not be able to piece together the images that are shown in comics

For example, in Figure 20, the image shows a character waving his arm and covering his mouth to avoid the smoke in the room from a fire If participants did not

have previous knowledge about human arm movements, the character might look as if he had three limbs on his right side Because participants had previous knowledge about human arm movements, the comic panel is understood as a character in motion

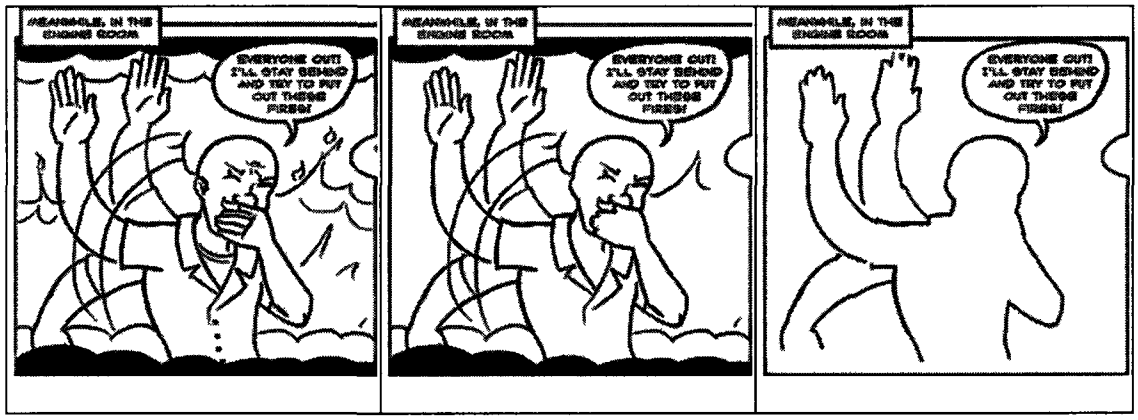

Figure 20 Comparison of the Low, Medium, and High Abstraction Comic Panels with Movement

In the center of Figure 20 is the medium abstraction comic panel With half the details of the low abstraction panel, the participants were able to understand and perform at the same level and speed as the low abstraction panel The same occurred with the high abstraction panel on the right of Figure 20 This panel had half the details of the medium abstraction panel, though no differences were found between participants' performance, speed, or view time scores Moreno (2007) removed extraneous information to assist retention of learned information This shows that it is not necessary to draw detailed imagery to gain positive performance results The results follow the theory in that participants' knowledge of human arm movements applied to all comic

panels, regardless of the details included Also, the amount of time needed to recognize the images was the same across levels

If comic readers were not able to utilize their previous knowledge and apply it to a variety of images, then the high abstraction comics would be more difficult to recognize and longer time would be needed to complete the study This was not the case in the current study Participants were able to apply their knowledge to a variety of images Because of this, a comic artist is not necessary for trainees to fully understand the training material and perform as well as others with more or less detailed imagery Prior knowledge is a major catalyst for researchers to fully understand how comic readers utilize mental tools

Figure 20 also shows how pictorial metaphors play a part in comics, particularly with movement Rather than blurred lines, as often seen in photographs with motion (Miller, 1990), the comic artist drew lines to depict the arm moving The non-literal depictions of movement, or pictorial metaphors, assist the reader in understanding the character's motion within a static image (Kennedy, et al , 1993) The arms are also shown in three separate stages so that the reader can piece the images together and form a complete animation in their mind This is possible because the readers are familiar with arm movements, that is, they are interacting with visual perception (Kimchi & Hadad, 2002), and storing this knowledge in long term memory (Noordman & Vonk, 1998) The long term sensory memories are later applied when the reader views the comics

Each level of symbolic abstraction connected comic strip imagery with image schemas (Mandler, 1992) because of the perceptual matching between the symbols presented, regardless of abstraction, and the symbols in long term memory This

perceptual element allows comics to communicate information across diverse populations (Knox, 2004), such as the military Cognitive load and working memory levels (Mayer & Chandler, 2001) seemed to be the same across groups as recorded times were not longer for higher levels of symbolic abstraction groups

Details, such as eyes on a face, are a part of schemas in long term memory (Paas et al , 2003), but are not essential to pattern matching for expert decision making (Klein, 2008) as shown in the current study when these cues were erased from the high abstraction comic strip presentation Selecting important information (Treisman, 1986) did not take longer in the high abstraction group, perhaps because the participants were able to piece the visual cues together to form an understandable match in long term memory

Gestalt principles, such as the law of similarity (Kubovy & van den Berg, 2008), are emphasized in Experiment 2 results because the image details are removed with only the basic imagery remaining This is particularly evident in the high abstraction group In the high abstraction group, several Gestalt principles can be applied to describe how participants perceived the imagery including the law of similarity, proximity, and good continuation

The law of similarity describes how similarly shaped objects are perceptually grouped together (Kubovy & van den Berg, 2008), whereas the law of proximity indicates that parts of a whole are grouped when spatially placed close together These principles are most evident in the high abstraction group because the lines were simplistic and drawn with the same line width Characters were also drawn with separate lines, but placed in close proximity to one another Because the character lines were close together

and had equal widths, participants were able to form a mental image of the characters without having a fully detailed drawing

CHAPTER 10

GENERAL DISCUSSION

In general, though, Gestalt principles explain only part of the participants' perceptual phenomena The laws of similarity and proximity (Kubovy & van den Berg, 2008) indicate that participants were able to understand the imagery in the high abstraction group However, instances such as trajectories that do not include a full line of path cannot be explained by laws such as the Gestalt principle of good continuation In this circumstance, Gestalt principles cannot explain how participants were able to understand imagery that was not fully drawn In this situation, image schemas (Mandler, 1992) were utilized to connect previous knowledge and experiences with minimal imagery to create an understandable event or object

A Picture is Worth a Thousand Words

The common theoretical thread between text and comics is image schemas (Mandler, 1992) Whether text is read, or an image is viewed, the information must be connected with long term memory and previous knowledge in order to understand it The benefit of using comics is that the description of the information through imagery requires less interpretation The current study results show that the cliché, "A picture is worth a thousand words," is valid The view time for comics took less than half of the time that participants took to read the text based media in Experiment 1, though both groups performed equivalently

In Experiments 1 and 2, participants were able to understand the images, regardless of abstraction level, because of image schemas such as PATH and LINK (Mandler, 1992) PATH applies to the low abstraction group in Experiment 2, also used

in Experiment 1, as well as the medium and high abstraction groups This image schema describes the physics behind the movement of an object, such as gravitational pull when objects are thrown upward PATH is shown in the current study comics throughout abstraction levels because the basic outline of characters always remains Movements such as running or falling require gravitational pull, and thus, the PATH image schema is utilized to fully understand the movements(s) The LINK image schema also applies to all comic abstraction levels in both Experiments 1 and 2

LINK describes the connection points between parts of an object (Mandler, 1992) such as an arm to a person This image schema is shown in the current study comics when a character in a smoke filled room waves his arm in stages, or three separate images With three separate images shown for a single movement, the participants utilized LINK to understand how the shoulder was attached and the rest of the arm moved up and down to form a waving motion Without LINK, the arm may have seemed to detach and the concept of the movement would have been lost

Sensorimotor contingencies are built upon the fundamental mental structures, image schemas (Mandler, 1992) Sensorimotor Contingency Theory indicates that visual perception of an object occurs when one experiences movement of the object and interacts with the object (Noe & O'Regan, 2002) The interactions, and anticipated actions, with the object are the sensorimotor contingencies Both theories work together to describe the basic mental structure, image schemas, and how experiences expand the structures, expanded by sensorimotor contingencies

Because Experiments 1 and 2 had several equivalent results in terms of accuracy, speed, and view time, the image schemas PATH and LINK (Mandler, 1992) and

sensorimotor contingencies (Noe & O'Regan, 2002) were also equally utilized in each comic abstraction level Image schemas have a foundation of basic physical principles, such as gravitational pull and connection of parts, that are expanded by sensorimotor contingencies and these mental processes can be applied to both simple and detailed imagery

The researcher hypothesized that the common theoretical thread between levels of abstraction in Experiment 2 were also image schemas (Mandler, 1992), though more research is needed to fully understand where differences between abstraction levels occur The number of details, particularly in the high abstraction group, needs future examination to discover when performance degrades if visual details are reduced further

Because participants were able to understand the comics when information was removed, a question remains concerning which specific information is most important Future research should address this issue, systematically removing information of various types from comic portrayals and measuring resultant comprehension

Future research should also examine the use of stick figures, for example As previously discussed, the time that participants are given to view the media should also be considered Although there was a significant difference between view time in Experiment 1, performance scores could change if the view time was less than the 15 minute maximum in the current study

The military needs effective and efficient training in the shortest amount of time possible The value of comics comes from the shortened training time and equivalently effective performance, as shown in the current study results The military has the capability to reduce text based manuals into comic books with minimal details and still

uphold their performance requirements By using comics for training, the military would have twice as much time to train their soldiers on other topics, or in real-world situations

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APPENDIX A

EXPERIMENT 1 TEXT

TEXT-BASED SCENARIO 1

Pgs 10-14 Sontag, S , & Drew, C (1998) *Blind Man's Bluff* New York Public Affairs Reprinted with permission

In the following scenario, you are Benitez – captain of the USS *Cochino*, a diesel powered submarine. The USS *Tusk* is another submarine that you will be interacting with

On a map, Murmansk sits on what looks like the base of the thumb of a land mass shaped like an inverted glove, its fingers defined by Norway, Sweden, and Finland The thumb is the Soviet Kola Peninsula, home to the operating bases of Vagenga (later called Severomorsk) and Polyarnyy These were among the Soviets' most important northern ports because they could be used year-round – kept warm enough to be free of ice by a branch of the Gulf Stream Polyarnyy was a submarine base, as well as home to the subterranean headquarters for the commander-in-chief of the Northern Fleet Secreted beneath brick-and-stone administrative buildings were the Soviet code rooms and communications centers

Austin was looking for telemetry signals coming from these bases or from ships nearby Because missile telemetries were usually broadcast in the highest ranges, intelligence officials had set Austin's black box to capture the higher frequency bands of a launch in progress If something were happening, he should be able to hear it Or so he hoped This spy mission was as much a guessing game as anything else There was no way to know whether the Soviets had planned any launches at all All Austin could do was spin the dials in his cubicle and listen for any activity He also had taken to wandering into the radio room and tuning into Russian voice communications Austin didn't speak Russian, and neither did the radiomen But Austin could pick out the Cyrillic alphabet in Morse code, one of those tricks he had learned to fill the tedium during his days on surface ships Now, as he sat clacking out Russian on *Cochino*'s manual typewriter, he imagined he could actually understand what he was typing In his

mind, one Soviet ship was making a daily report, telling its command how much rice was on board, that the fruit had all been eaten Another was reporting the day's sick list

Three days passed, and Austin had still collected only a few Soviet voice transmissions Benitez decided to make one more nighttime pass to give Austin a chance to find more Austin would have been willing to sit for weeks He was itching to nab the grail, to record some Soviet missile telemetry

It was on this last evening that something began to come through It didn't sound like a launch, but Austin had also been told to look out for equipment tests Maybe that's what was going on Maybe the Russians were tuning up their gear, getting ready for a show He asked Benitez to order a turn, to try to position *Cochino* for a clearer signal Even after that, Austin was still not sure what he was hearing, or even whether it was coming from land or from sea This wasn't voice, that much he knew

For a moment the frequencies seemed about right for a weapons test But there wasn't nearly enough coming through – in fact, not anywhere near the wash of sound that would have signaled the telemetry from a missile test Intelligence officials back home might have imagined that the Soviets were engaged in endless launchings, readying to take their missiles to sea But if that were the case, the Soviets had taken a break just as *Cochino* came near Austin's spy mission was a failure, at least so far He was scheduled to get another try later, but for now, *Cochino* was going back to her initial mission She was going to play hide-and-seek with *Tusk* so the two subs could learn like any young predators how to become hunters and killers

By now, even Benitez was disappointed as he turned Cochino from the area For all of the trouble Austin's orders had caused, the commander would have liked to have been able to go back and say, "Ah, we got something," to log in his patrol report that "we intercepted this or we intercepted that ' Still, as he began ordering course, west and north, he was glad to be getting on to what he considered his primary mission In fact, he was feeling quite light-hearted It was Wednesday, August 24, a day before Cochino's fourth birthday, and Benitez had called for an early celebration

The cooks were at work, preparing a large birthday cake and a steak dinner that even Austin had to agree was better than Spam There were songs, jokes, and prerecorded birthday wishes set down that morning by some of the men eating in the

mess Later, Benitez would log, "It was a happy ship, and in the wardroom we expressed the wish that the next birthday would find us all together on board *Cochino* "

Early the next morning, *Cochino* spotted *Tusk* off her starboard beam By 10 30 A M that Thursday, *Cochino* began moving ahead at snorkel depth It was her turn to hide *Tusk* has already moved away to perform the submarine version of counting to ten

It was a gloomy day, misty and gray with rough seas The radio room had earlier picked up a forecast of polar storms, and the winds had been blowing for hours The waves rocked *Cochino*, and the planesmen struggled to maintain steady depth, as the crewmen braced themselves, grabbing chart tables and overhead pipes Others lunged to catch sliding coffee cups and tools The forward engine room got on the squawk box and told Benitez that water was pouring into the sub through the snorkel, which should have been automatically capped watertight by a valve designed to slam shut as soon as its sensors got wet

Benitez sent Wright, his XO, back to investigate as the engines cut off for lack of air Just about two minutes later, there was a muffled thud and the sub shuddered Austin slammed hard against the viewer on the number 2 periscope He was certain they had bumped a "deadhead," a log, and just as certain that he'd have two black eyes to prove it

But what was actually happening was far worse An electrician saw sparks coming from one of the two compartments that each held two of the massive batteries that powered *Cochino* when she was underwater The compartments were located toward the middle of the submarine The batteries in one of the spaces, the "after-battery" compartment, were on fire and smoke was filling the room

"Clear the compartment," the electrician shouted, staying behind to try to find a way to put out the fire Men began moving forward to the control room, bringing news to Benitez

"Fire in the after-battery!" someone gasped Benitez answered with an order "Surface!" Then he turned to one of the new devices they were testing, an underwater phone, and sent a message to *Tusk* "Casualty Surfacing "

The men blew ballast, and *Cochino* broke the surface within moments, rocking fiercely in the stormy seas, sixteen-foot waves crashing against her hull The captain

headed back to the conning tower Then he opened the hatch and climbed out onto the weather bridge, a large protrusion off the sub's notched steel sail From here he was well above the main deck, trying to scan for *Tusk*, his binoculars all but useless

Calling down the ladder to the control room, Benitez sent one of the sub's youngest officers, Ensign John P Shelton, back to report on the fire Other men ran to try to help fight the flames, but there was a terrible delay The emergency breathing apparatus that should have protected the lead man from the smoke and gases wouldn't work By the time he could send for another, the watertight door leading to the room was jammed, perhaps held by the pressures building from within or melted shut by the head of the fire

Inside, one battery seemed to be charging another, emitting highly combustible hydrogen gas as a by-product Unless someone could break into the fiery compartment, unless someone could push a wrench against heavy switches to break the connections between the burning batteries, the hydrogen would build to critical levels and there would be another explosion With a large enough blast, *Cochino* could be lost

Benitez left the bridge and headed to the control room There he checked the hydrogen detectors They still read zero For a moment he was thankful, but just for a moment Then he realized the detectors simply weren't working He knew there was only one option Somebody was going to have to force their way into the battery compartment from the other side, from the forward engine room Somebody had to try again to get in to disconnect the batteries Just then, Wright phoned forward – he was going to try to do just that He outlined his plan tersely and without an unnecessary rendition of the risks Both he and Benitez knew that the battery space could explode at any moment, that any attempt to enter might prove fatal They also knew that Wright had to try

Worried, Benitez climbed back to the bridge to look for the only help nearby, the men on *Tusk* He was there when he felt the second explosion, a blast that ripped off a flapper that had isolated smoke from the burning compartment from the rest of the ventilation system Smoke and toxic gases were now pouring through to the forward part of the sub Someone called up to the bridge The men below were in serious trouble

Benitez ordered an evacuation, calling topside anyone who wasn't manning a critical position or fighting the fire The men began moving forward, any instinct to panic overwhelmed by the almost unbelievable magnitude of the casualty One after another, some gasping for air, they made their way to the bow, the very front of the sub, and climbed up the ladder leading to a topside hatch Under captain's orders, they headed to the handrail at the lee side of the sail and lashed themselves to it

It was bitter cold, and waves were still slamming down on the rolling boat Some of the men had come straight out of the sack, wearing only socks, T-shirts, and skivvies A couple were wrapped in blankets Among them, they had only a few life jackets, and no food, no water, no medical supplies They were, for the most part, defenseless against the cold and pounding seas

By now, there were forty-seven men lashed on deck Another twelve had crowded onto the bridge alongside Benitez, though the space was designed to hold seven men There were still eighteen men back aft, trying to regain propulsion and fight the fire The captain looked down at his crew, then out at the horizon Where was *Tusk*? The blaze had now been raging for half an hour

Someone managed to restart *Cochino's* engines Benitez began to have hopes that he could drive the boat to shore when a wave came up and swallowed her stern A cry emerged before the water receded

"Man overboard! Man overboard!" It was Joseph Morgan, one of the mess cooks

END

TEXT-BASED SCENARIO 2

Pgs 30-34 Sontag, S , & Drew, C (1998) *Blind Man's Bluff* New York Public Affairs Reprinted with permission

In the following scenario, you are Bessac – captain of the USS *Gudgeon*, a diesel powered submarine.

It happened on Monday, August 19, 1957, sometime after 5 00 P M , Soviet Pacific Coast time *Gudgeon* had been submerged for about twelve hours It would take two or three hours to travel to the isolated spot where she would snorkel, and then several more to take on enough air and create enough electricity to last through the next day Already, the air on board had become heavy It smelled worse than the usual diesel foul, and it tasted just as bad

A bunch of men were in the mess watching the first reel of *Bad Day at Black Rock* Over the whir of a 16mm projector, Spencer Tracy, Lee Marvin, and Ernest Borgnine were playing out the days just after World War II The movie was reasonably new What submarines lacked in water, space, and privacy the Navy tried to make up for with good movies and good food

Then, for a moment, the sub listed sideways Only slightly really, the sort of sway that normally happens beneath the surface in rough waters But in the calm water off Vladivostok, that sort of list only happened when the sail broached, catching a swell Then *Gudgeon* began to dive Again, it was nothing extreme, not an all-out plunge This was gentler, just an angle that the crewmen could feel under their feet

Suddenly the alarm rang There was nothing subtle about the call that came out over the squawk box "Battle stations!"

Now everyone was up and running at once, scrambling out of bunks, out of the mess, out of just about every corner, squeezing past one another through passageways not much wider than one man They were grabbing on to the bars welded over the oval watertight doors, shooting their legs through to the next compartment, shoulders and head following They came sliding down ladders and down stairs that weren't much more than ladders All of them were making more noise than they could afford

"We broached," one man shouted to anyone who was there to hear "The damn Russians are up there And the old man just took her deep "

Some of the other men thought the electronic countermeasures mast had been left up too long It was about a foot wide and 18 inches tall, and the officer of the deck was supposed to bring it down the instant it tasted radar signals that meant the Soviets might be honing in on *Gudgeon* Normally the mast was up only as long as the scope was, say, 30 seconds at a time But for these trips near the Soviet coast, the mast was kept up a bit longer, as other intelligence antennas had been added on as branches Either the order to take it down came too late or *Gudgeon's* depth control were handled badly, perhaps leaving both the mast and part of her sail exposed

Either way, anything sticking out of these calm waters would have made *Gudgeon* all too easy to spot, and spotted she was Soviet ships were heading her way even as Bessac began shouting the orders for evasive action Taking his boat down deep, he was looking for a temperature layer, a mass of cold water that could hide his sub by reflecting back to the surface any sonar pings aimed down from ships above The Soviets would definitely be going active, sending out the deadly accurate sound beams that created the most complete picture of what was below water They had no reason to try to listen through the static of passive sonar, no reason not to make noise They weren't the ones being hunted

One hundred feet, two hundred feet, Bessac wasn't finding that layer he could hide under Three hundred feet

Then the crew heard it "Ping Ping Ping " The Soviet probes rang steel chills through *Gudgeon* and her crew A ship had zeroed in on them Bessac began taking the sub deeper and back outside the 12-mile limit Many in the crew were convinced they had made their escape, but the Soviets were continuing to chase Operating just on batteries and submerged, *Gudgeon* couldn't outrun them, couldn't do much better than a few knots

By now, just about every man on board was focused on getting away Planesmen held the sub steady through the dive Other men kept an eye on the depth gauges Bessac stood in the cramped control room issuing orders Lieutenant John O Coppedge, the southern-smooth executive officer, "Bo" to the crew, was by the captain's side

In stations set out in a circle around the captain were the fire control officer, who sat ready to aim and fire weapons if given the order, and the quartermasters, those navigators who stood over charts plotting the course changes as *Gudgeon* moved to elude her tormentors Out one watertight door, just outside the control room, the sonar techs sat in their darkened closet watching screens and trying to count propeller sounds

There were two ships above, then more, all joining to pin down the *Gudgeon*

Men began taking note of their status *Gudgeon's* batteries were at that end-of-the-day low, her air that end-of-the-day foul And there was no way to run the diesel engines and bring in fresh air or recharge, not unless Bessac could drive *Gudgeon* near enough to the surface to raise her snorkel pipe and keep it there until the air was cleared Carbon dioxide levels were already high enough that some of the men were feeling nauseous, others had headaches, the kind where it felt as if the tops of their heads were coming off This was the worst time of the day on any diesel sub, and the absolute worst time to get caught

Unessential equipment was shut down to conserve power and to squelch noise The ice machines were off The lights were dimmed down to emergency levels, more glow than illumination Fans and blowers were off

Bessac gave the order to switch to relaxed battle stations, allowing many in the crew to take to their bunks to conserve oxygen Above, a ship pinged *Gudgeon*, driving her toward another ship, which repeated the sonar assault Every ping reminded the crew that someone on board had made a mistake, a big one

Word came from the sonar shack There were at least four ships above now The men cursed "Charlie Brown," their name for the Soviets when they weren't using more colorful descriptions

Then came another round of sonar pings They were followed by something else, something far more terrifying

With a series of "pops," a wave of small explosions rained down and around *Gudgeon* She had been trying to change course again, trying to elude her captors And they had answered The Soviets were dropping light depth charges – they sounded like hand grenades – into the water

The sounds came through the hull, loud The boat was okay, *Gudgeon* could withstand these small explosions But what if the Soviets followed through with the real thing, with full-sized depth charges?

Bessac began giving orders for a new set of evasive maneuvers In the control room, the men worked, straining to listen beyond the sub Others lay still in their bunks, listening as well, waiting for the thunder of bigger explosions, the kind that meant *Gudgeon* might never surface again

The younger seamen were noticeably nervous The grizzled vets, the few who had been through World War II, could hide their fear better, but for them this moment was actually far worse They knew what a depth charge could do They knew that their boat's namesake, the World War II sub named *Gudgeon*, was lost in the Pacific in 1944 and was believed destroyed by enemy depth charges They had lost comrades on subs of that era, and some of them had been on boats that just barely escaped when those charges fell They had felt the furious shocks, been drenched as seawater spurted through the wounded pipes of their fleet boats, wondered how long they could hold out inside fragile steel

The Soviets made another pass, then another, raining down pings and grenadelike charges

"Stay calm, we'll get out of this," Bessac muttered to a young auxiliary man, still in his teens

The youngster was already sporting talismans against catastrophe, tattoos of a chicken and a pig, one seared onto each foot That was a tradition of sorts, taken from an old Hawaiian legend Chickens and pigs, it was said, would always find something to float on and would never drown Several of the men were marked the same way

By now, the siege had been going on for nearly three hours Bessac continued to look for that temperature layer, taking the sub down to test depth – about 700 feet – and then a little farther No luck Maybe there was a layer at around 850 feet down *Gudgeon* should have been able to withstand the sea pressure even at that extra hundred feet or so below test depth, and Bessac probably would have risked it But there was another problem, one that prevented the captain from testing the extremes something had gotten caught in the outer door of the garbage ejector earlier that day Everything that

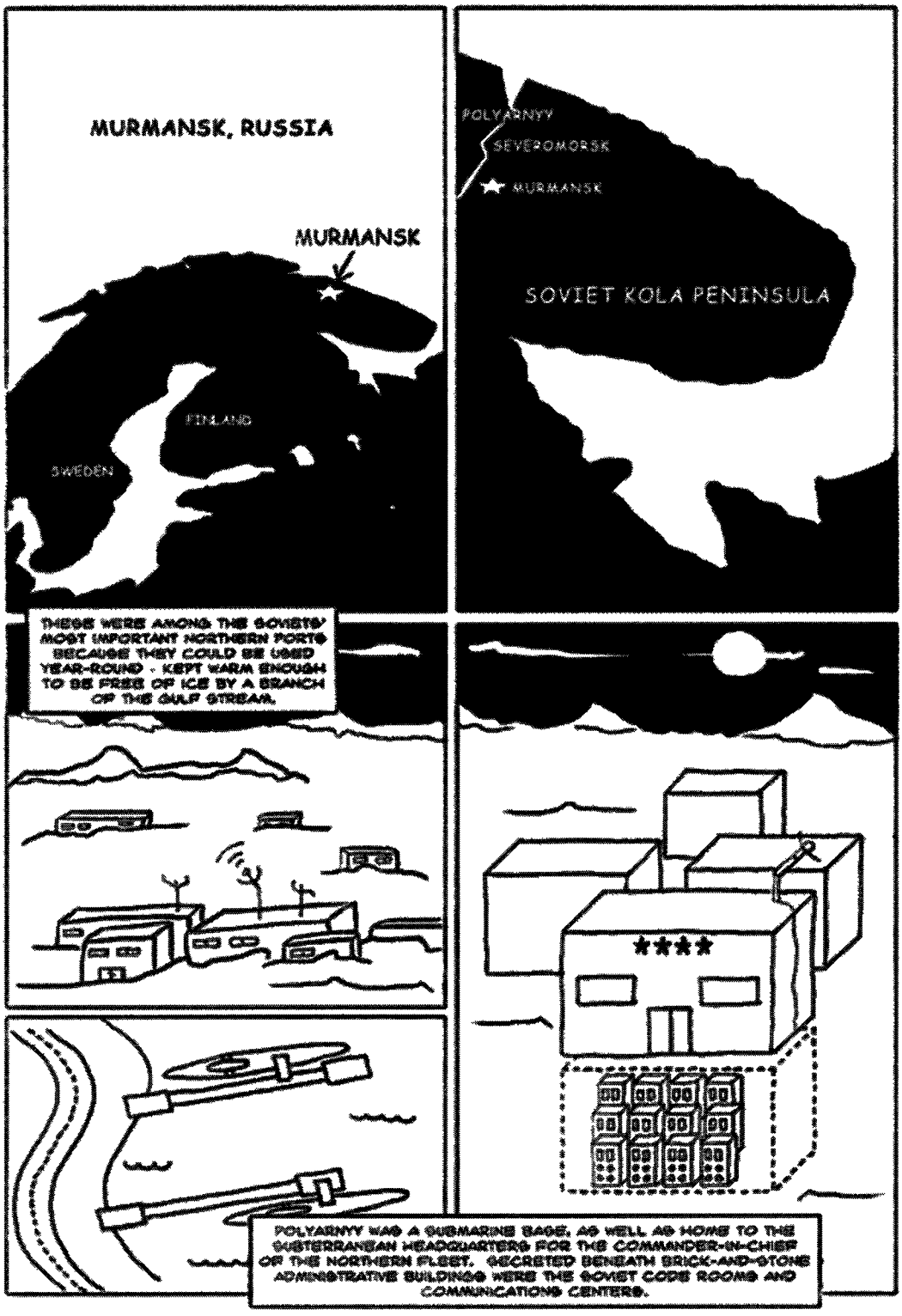
went into the ejector was supposed to be bagged and secured Everybody on board knew that Normally a column of water is forced through the opening, and the water, the garbage, all of it, is forced out to sea But someone had just tossed something in there, probably thinking nothing of it, and whatever the object was had jammed

Now there was just the inner ejector door, one piece of steel, holding the ocean back Even at a depth of just 200 feet, enough water could be forced by sea pressure through a one-inch hole to overwhelm pumping systems and sink a sub If the inner plat covering the trash ejector gave way now, with *Gudgeon* as deep as she was, she could be lost

One of the sub's senior enlisted men, a chief petty officer, had carried a bad feeling about the ejector all day, long before the Soviets came He had suggested sending someone swimming outside of the sub to clear it But Bessac decided they couldn't risk that kind of maneuver It wouldn't have been an issue if *Gudgeon* weren't now in a position where a little more depth might save her But there could be no going deeper END

APPENDIX B

COMICS
SCENARIO 1
Page 1 of 6



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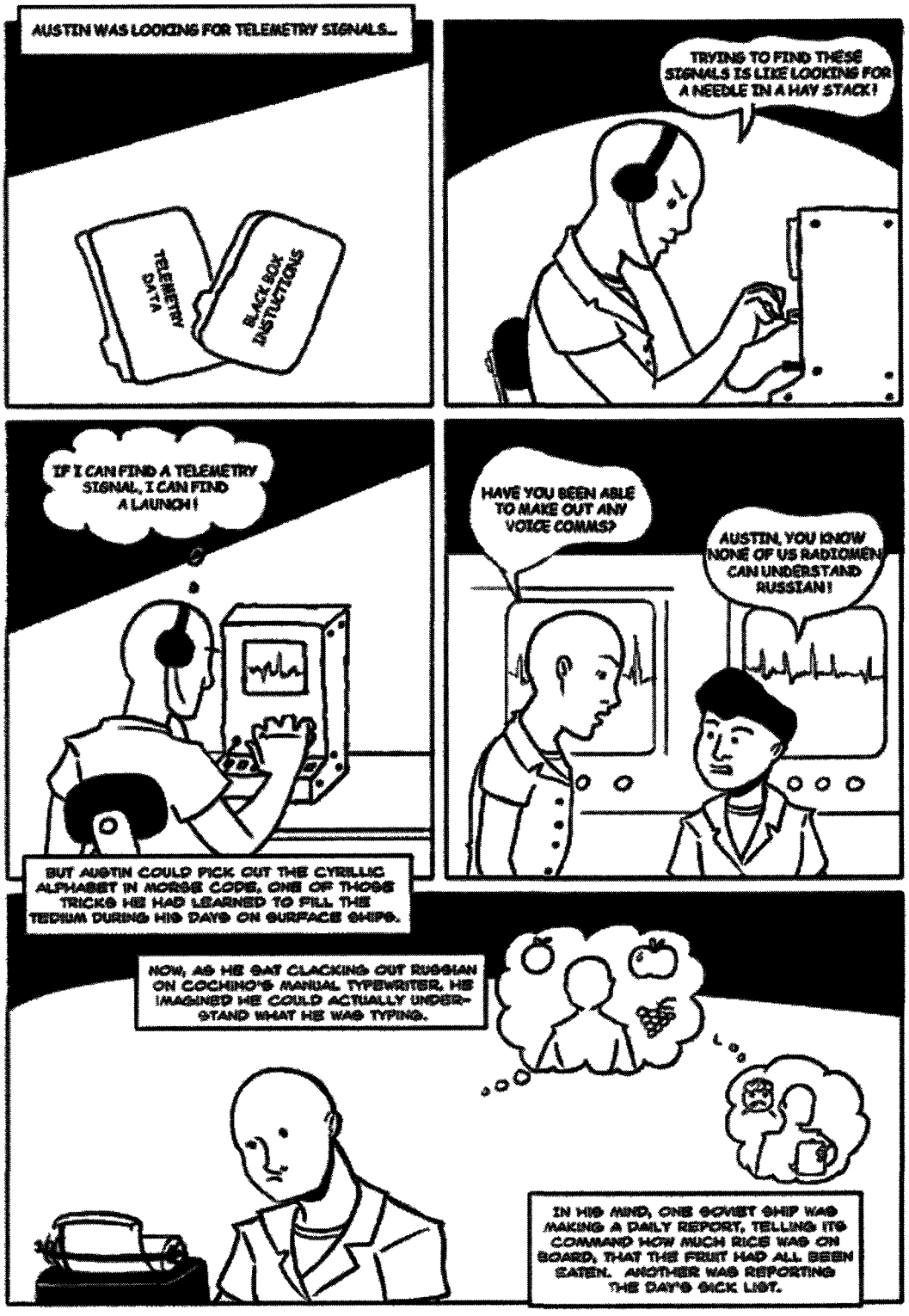
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IN HIS MIND, ONE SOVIET SHIP WAS MAKING A DAILY REPORT, TELLING ITS COMMAND HOW MUCH RICE WAS ON BOARD, THAT THE FRUIT HAD ALL BEEN EATEN. ANOTHER WAS REPORTING THE DAY'S SICK LIST.

Page 3 of 6


AUSTIN THIS IS THE LAST NIGHT PASS WE CAN DO.
%*$#, I AM WORKING AS FAST AS I CAN SIR!
I BELIEVE I HEAR SOMETHING SIR. IT DOESN'T SOUND LIKE A LAUNCH BUT IT MIGHT BE SOME EQUIPMENT TESTS. IF YOU ORDER A TURN, I CAN TRY TO GET A CLEARER SIGNAL.
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WOULD HAVE BEEN NICE TO BE ABLE TO REPORT SOMETHING, INTERCEPT ANYTHING. OH WELL. THE COCHINA'S FOURTH BIRTHDAY TOMORROW WILL BE REASON ENOUGH TO CELEBRATE.

Page 4 of 6


THE NEXT DAY WAS GLOOMY AND STORMY. IT'S COCHINA'S TURN TO HIDE. COCHINA SEES THAT TUSK HAS ALREADY MOVED AWAY TO PERFORM THE SUBMARINE VERSION OF COUNTING TO TEN.
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SIR! FIRE IN THE AFTER-BATTERY!

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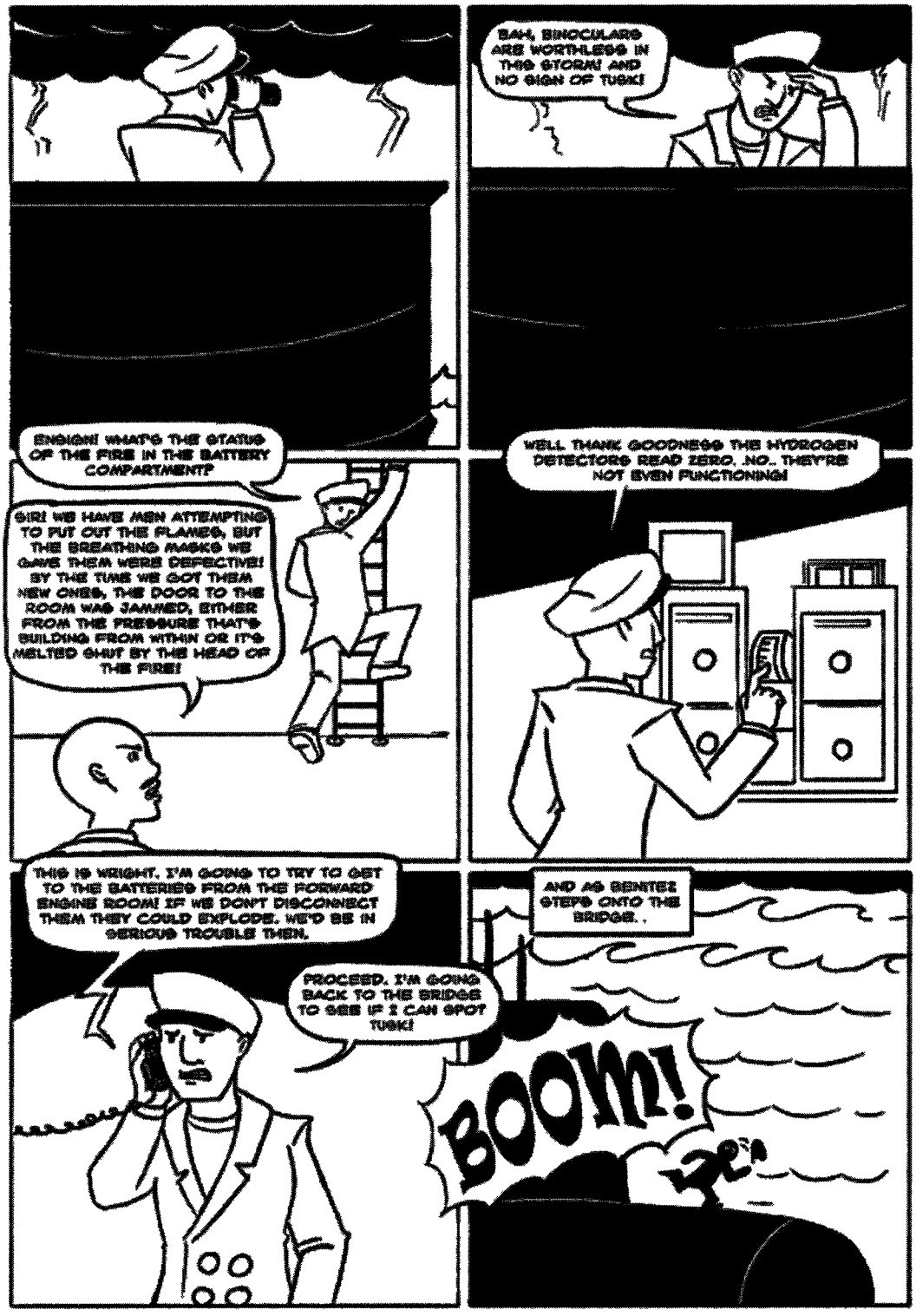
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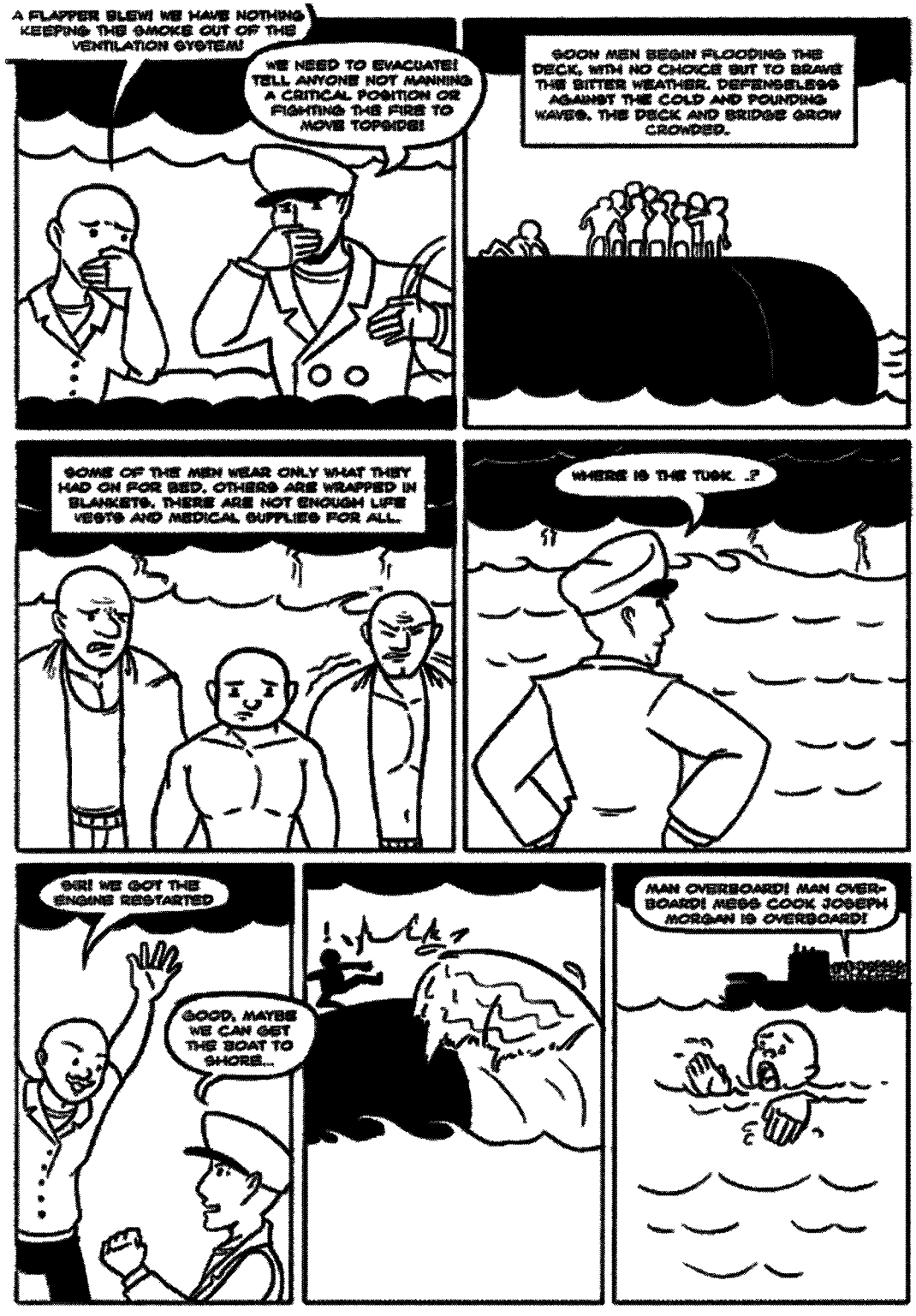

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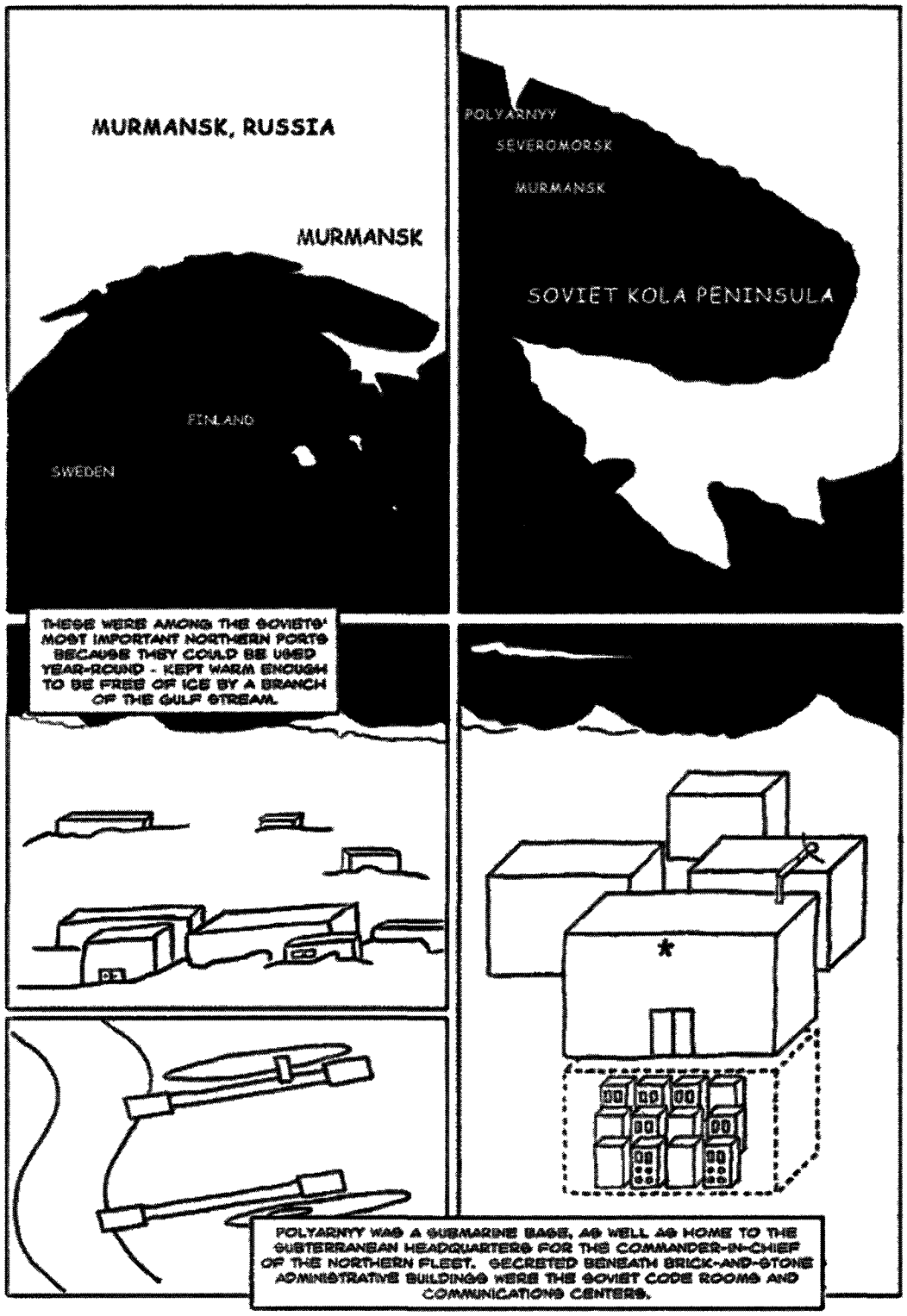
SCENARIO 1 HALF DETAIL

Page 1 of 6_HD



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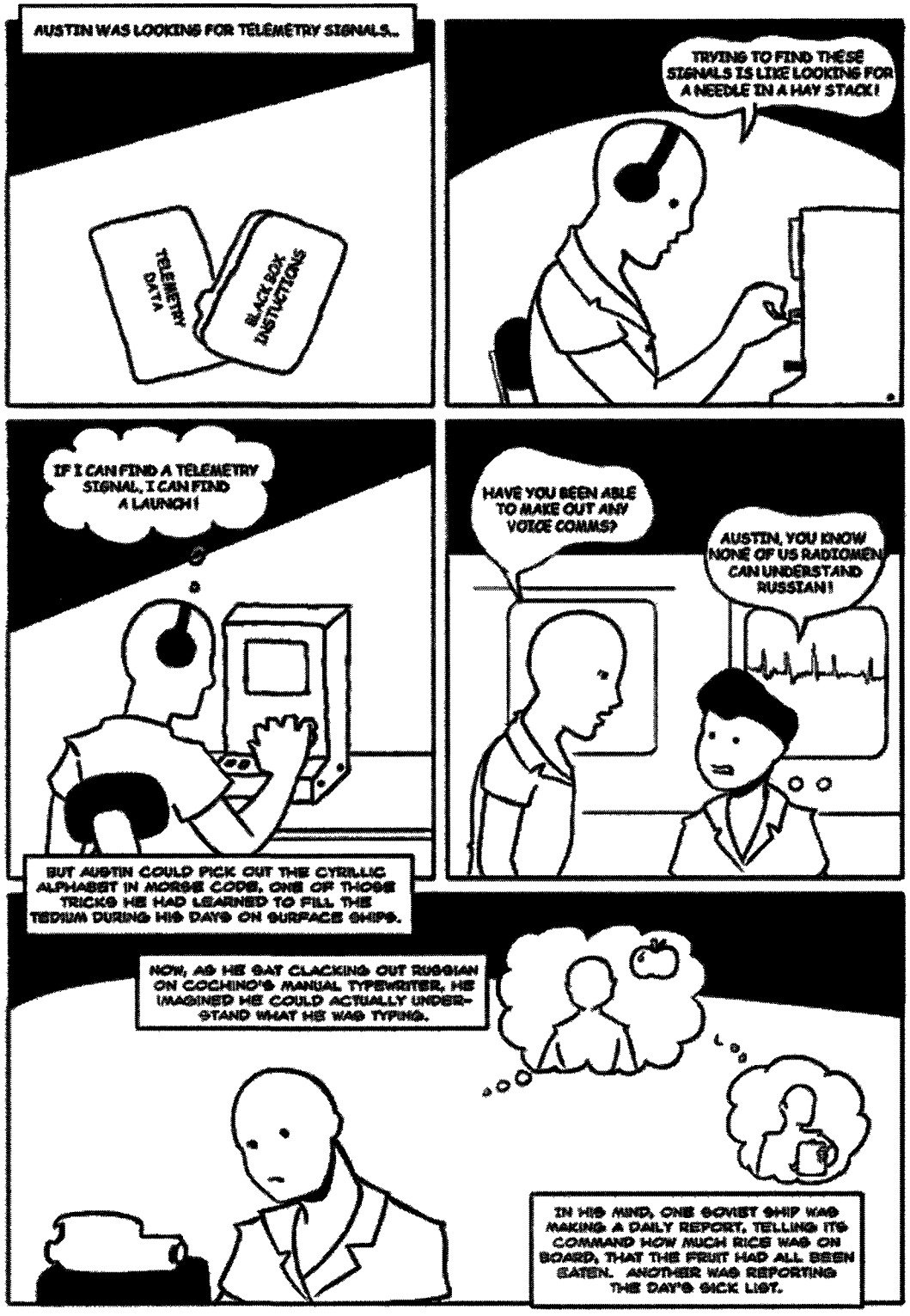
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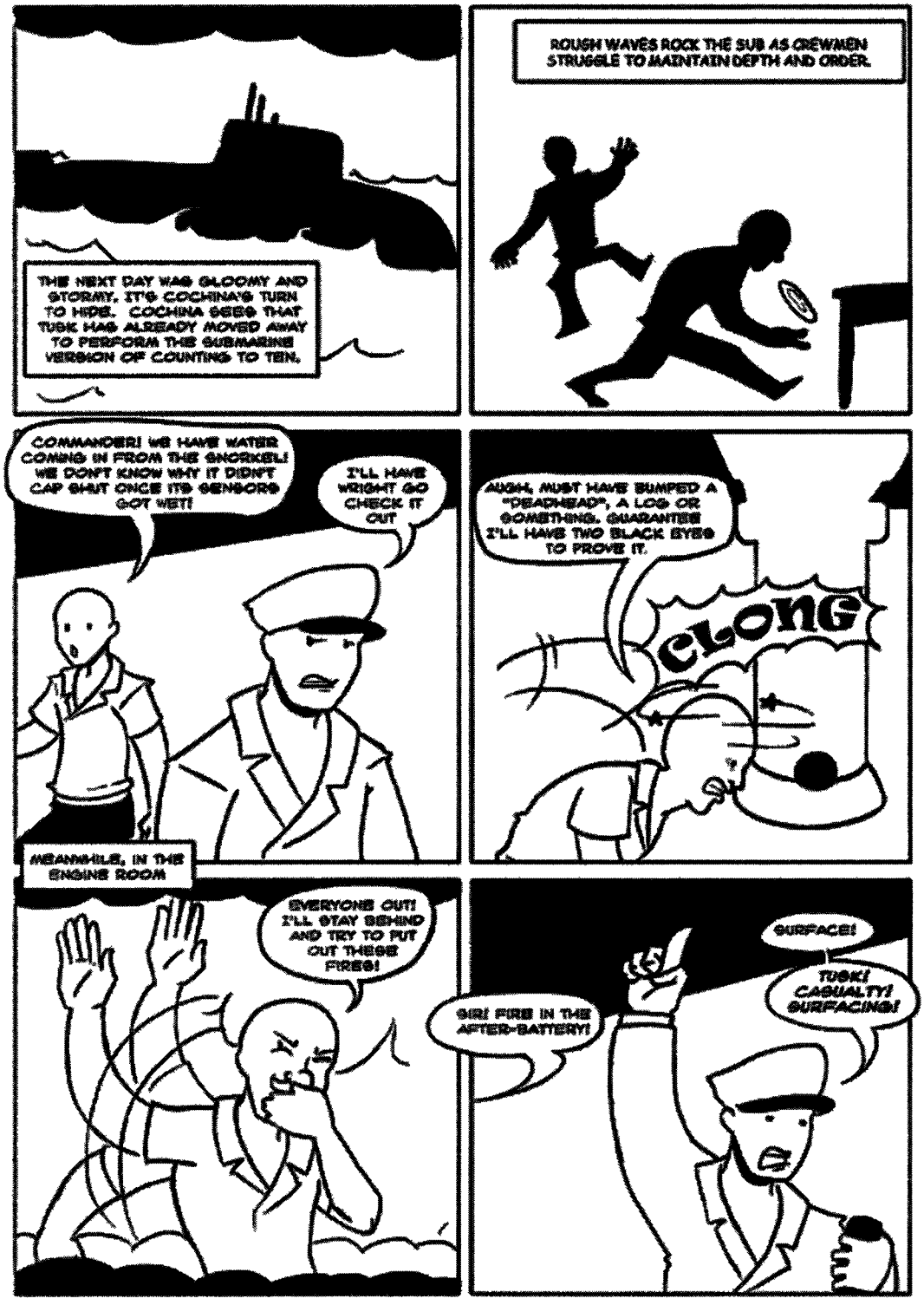
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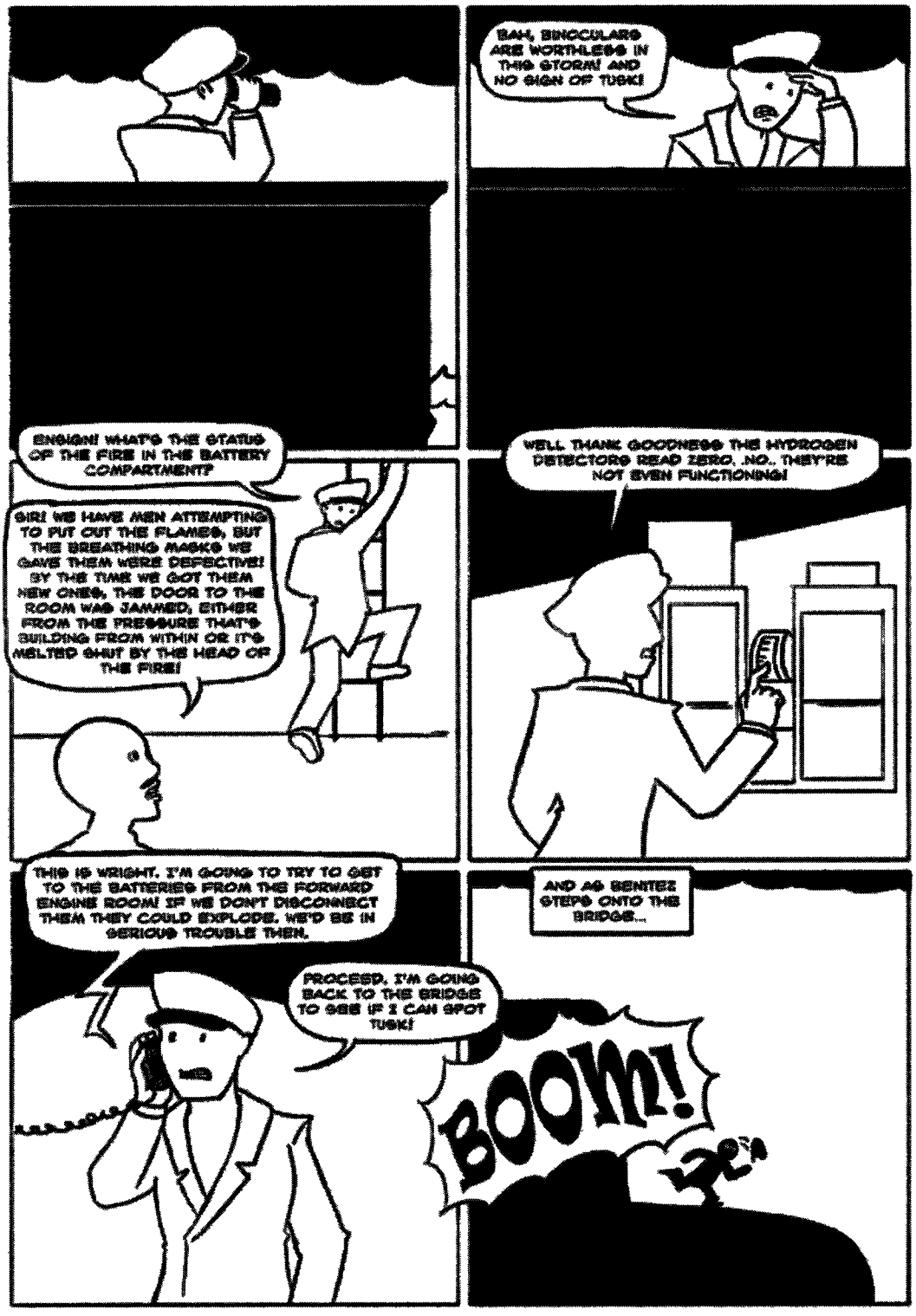
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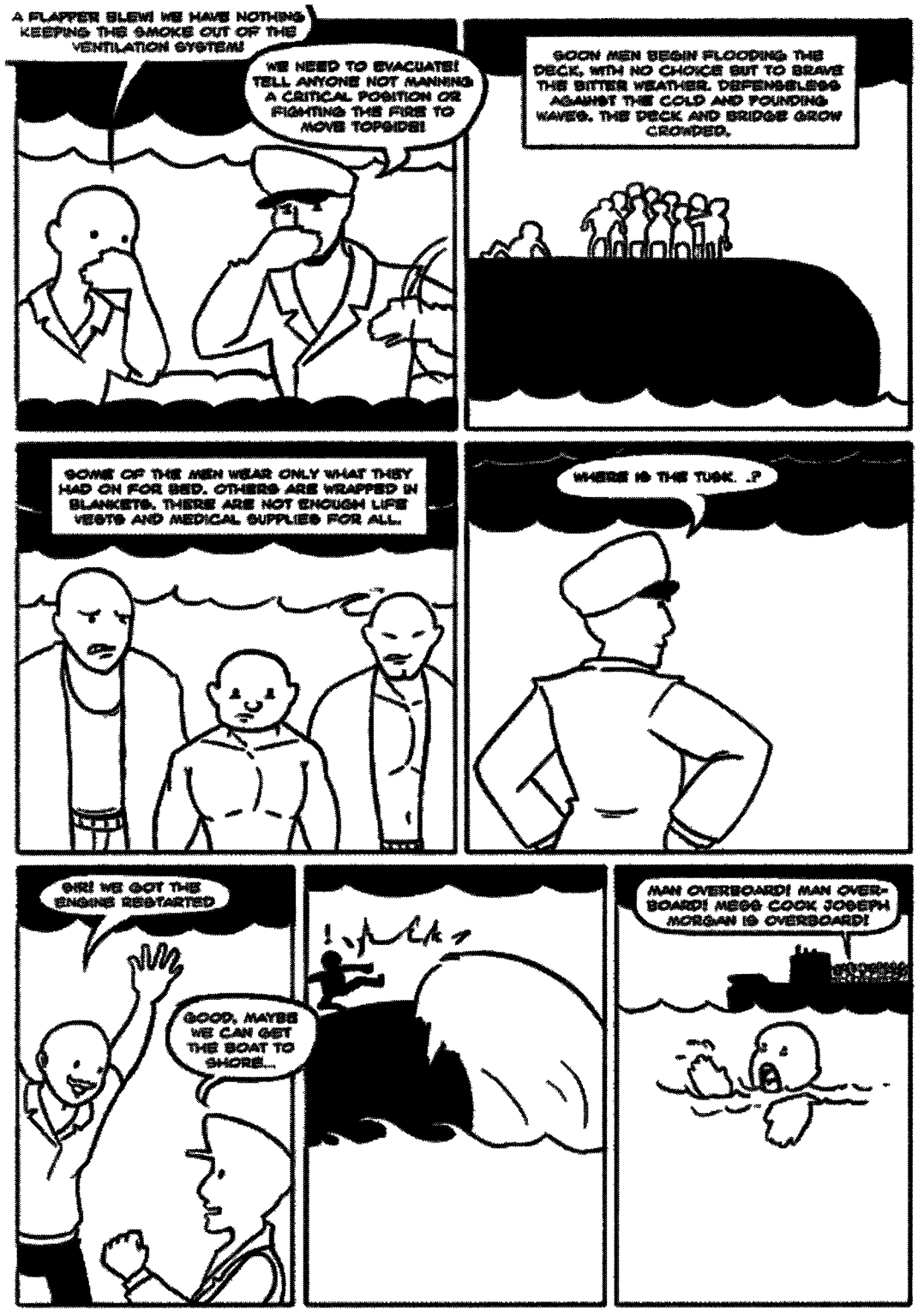
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SCENARIO 1 NO DETAIL

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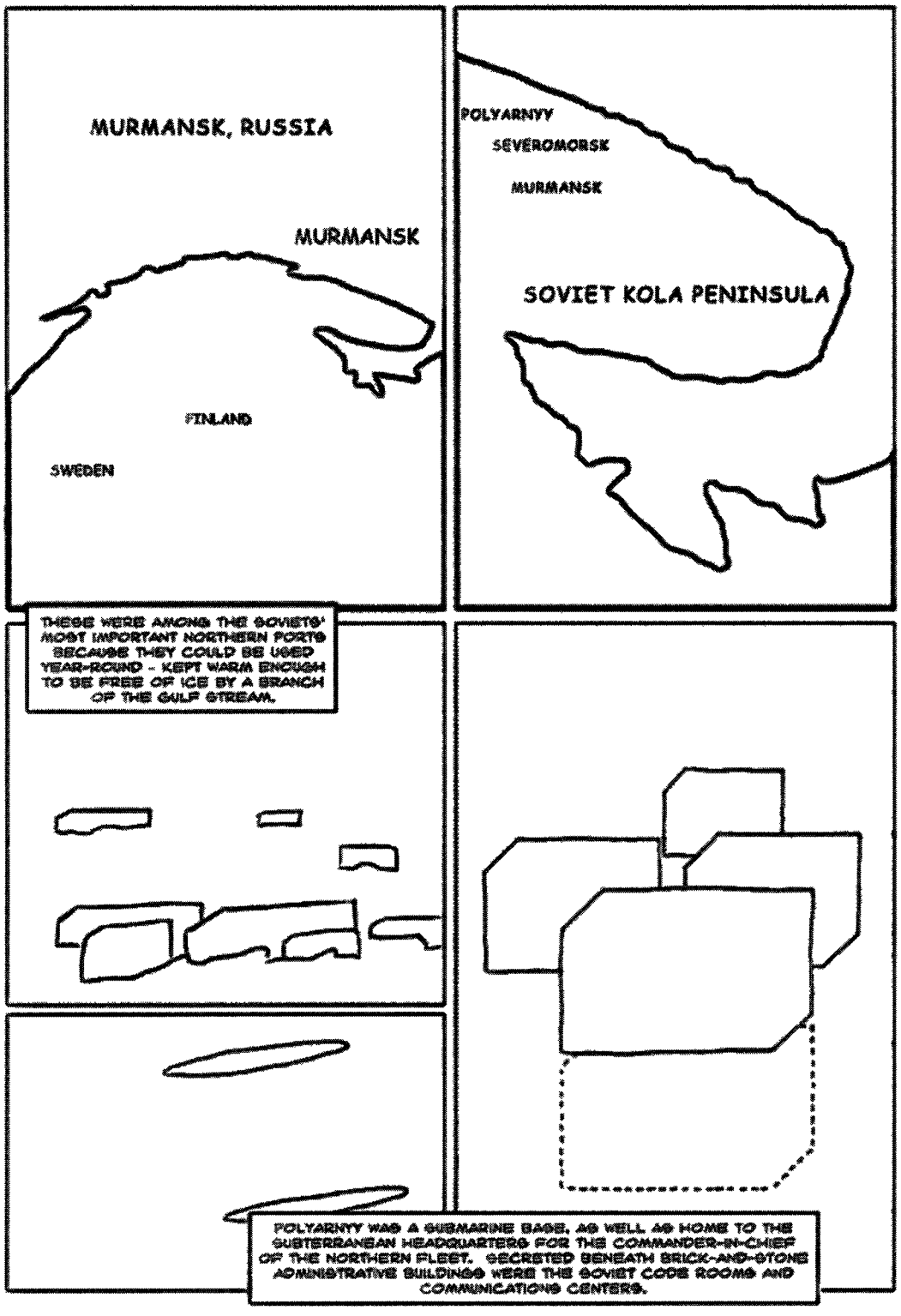

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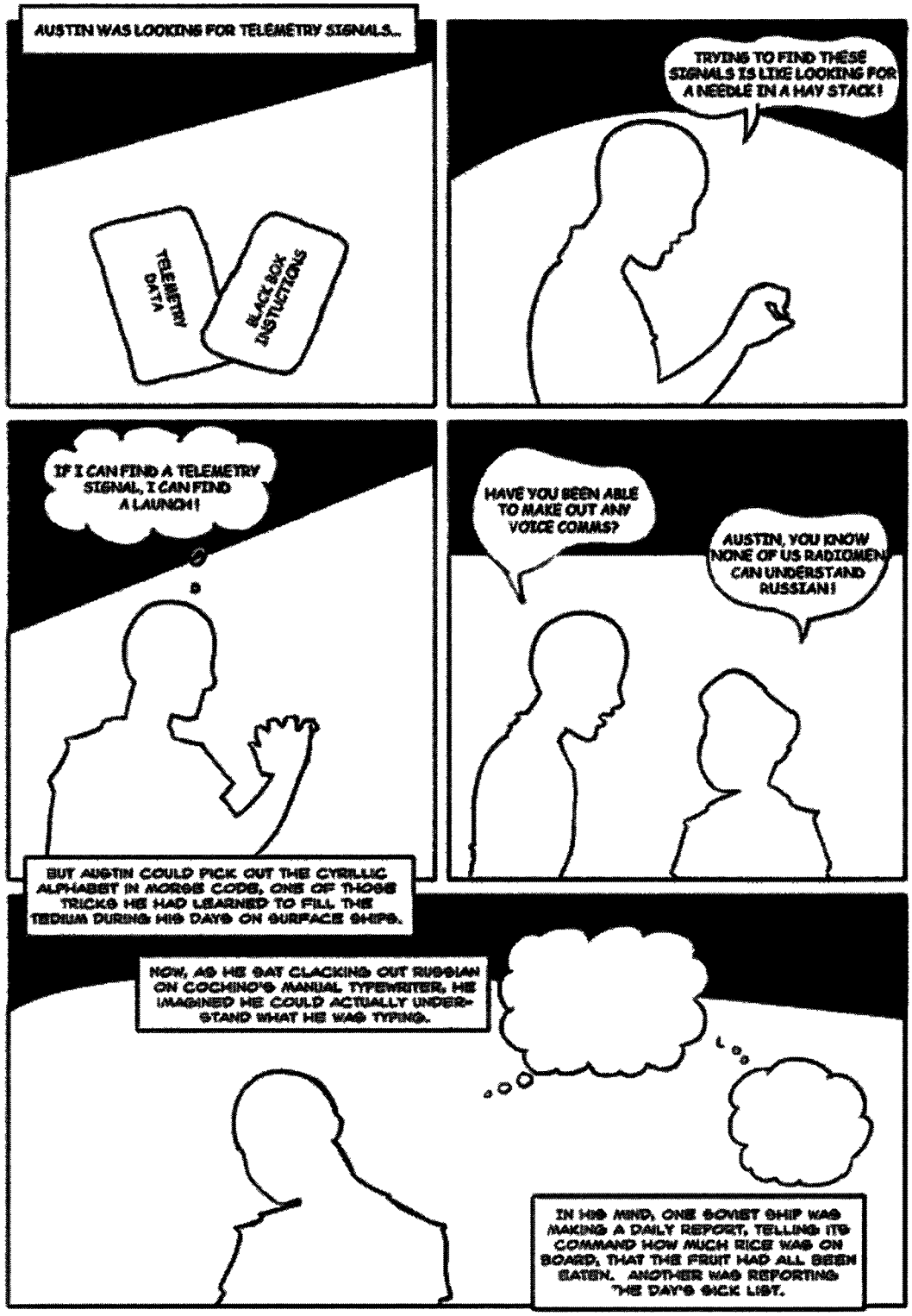
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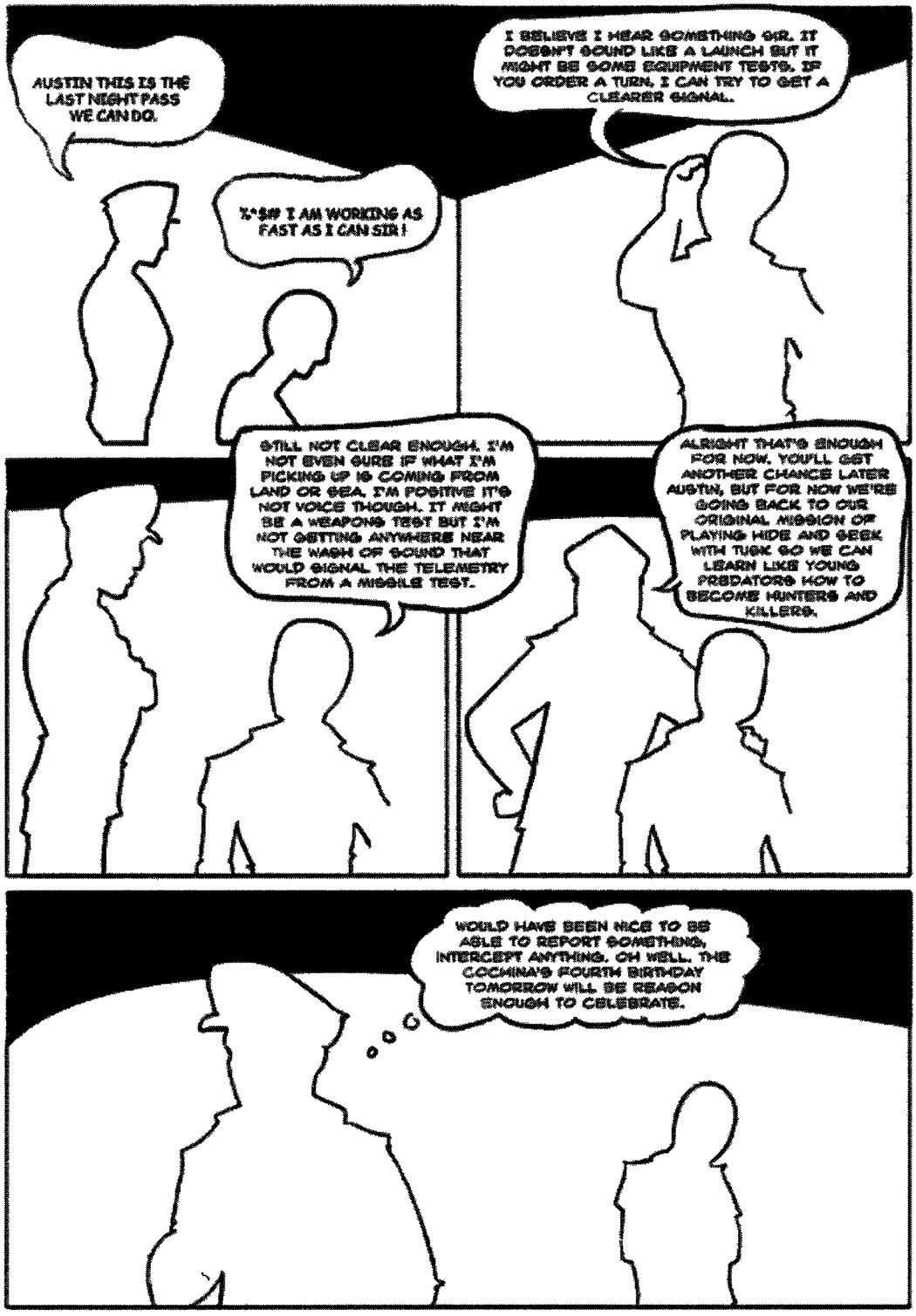
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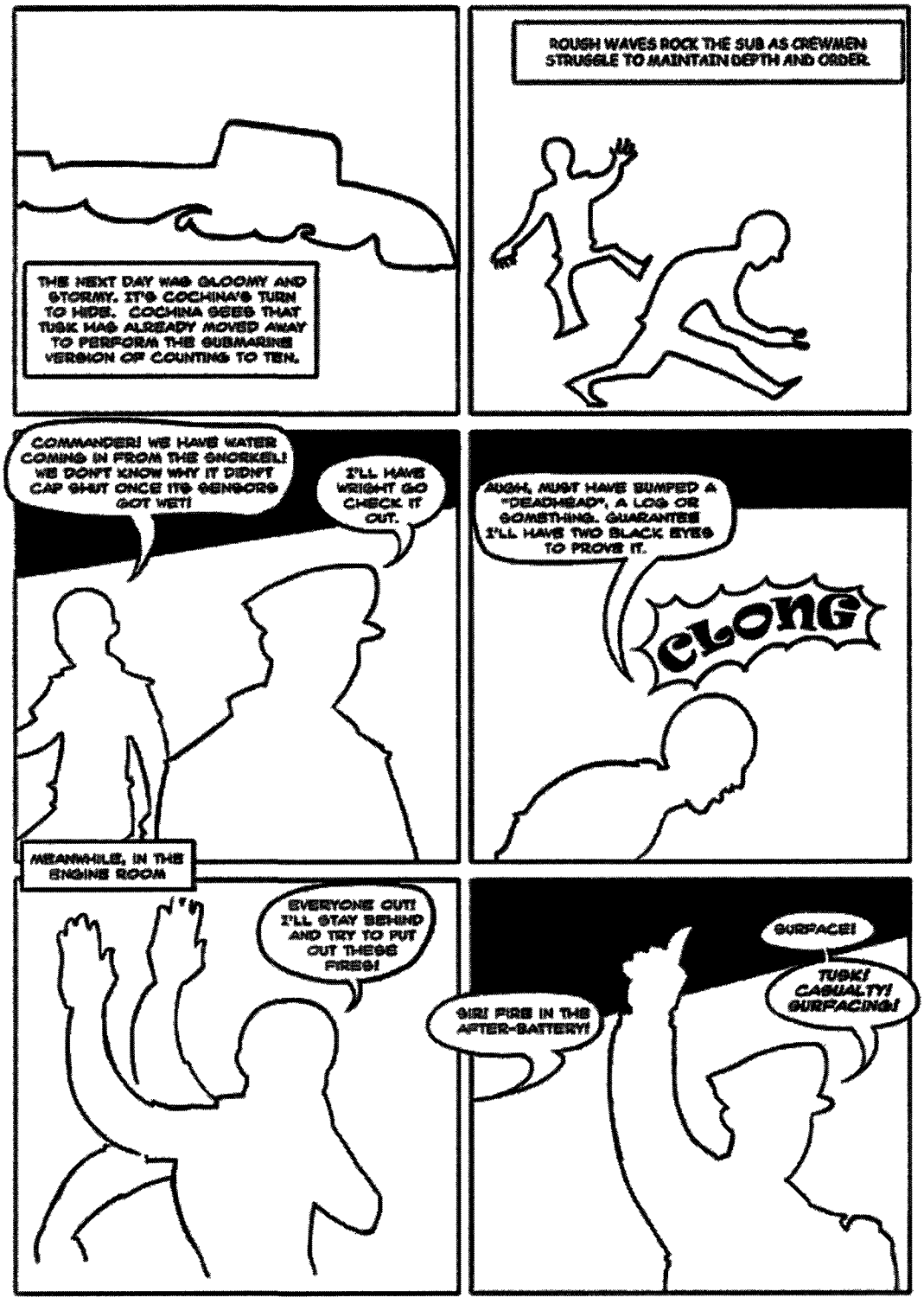
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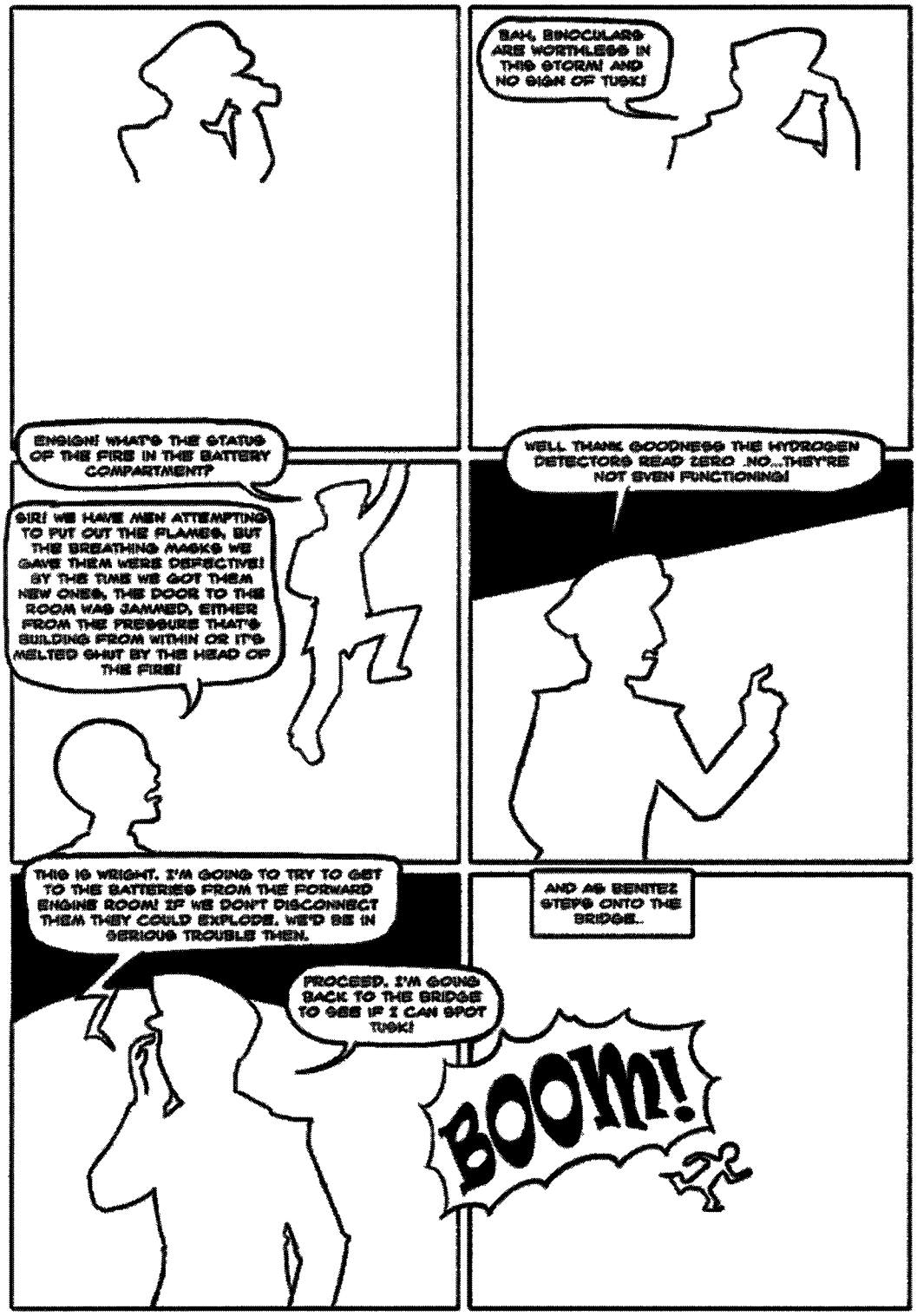
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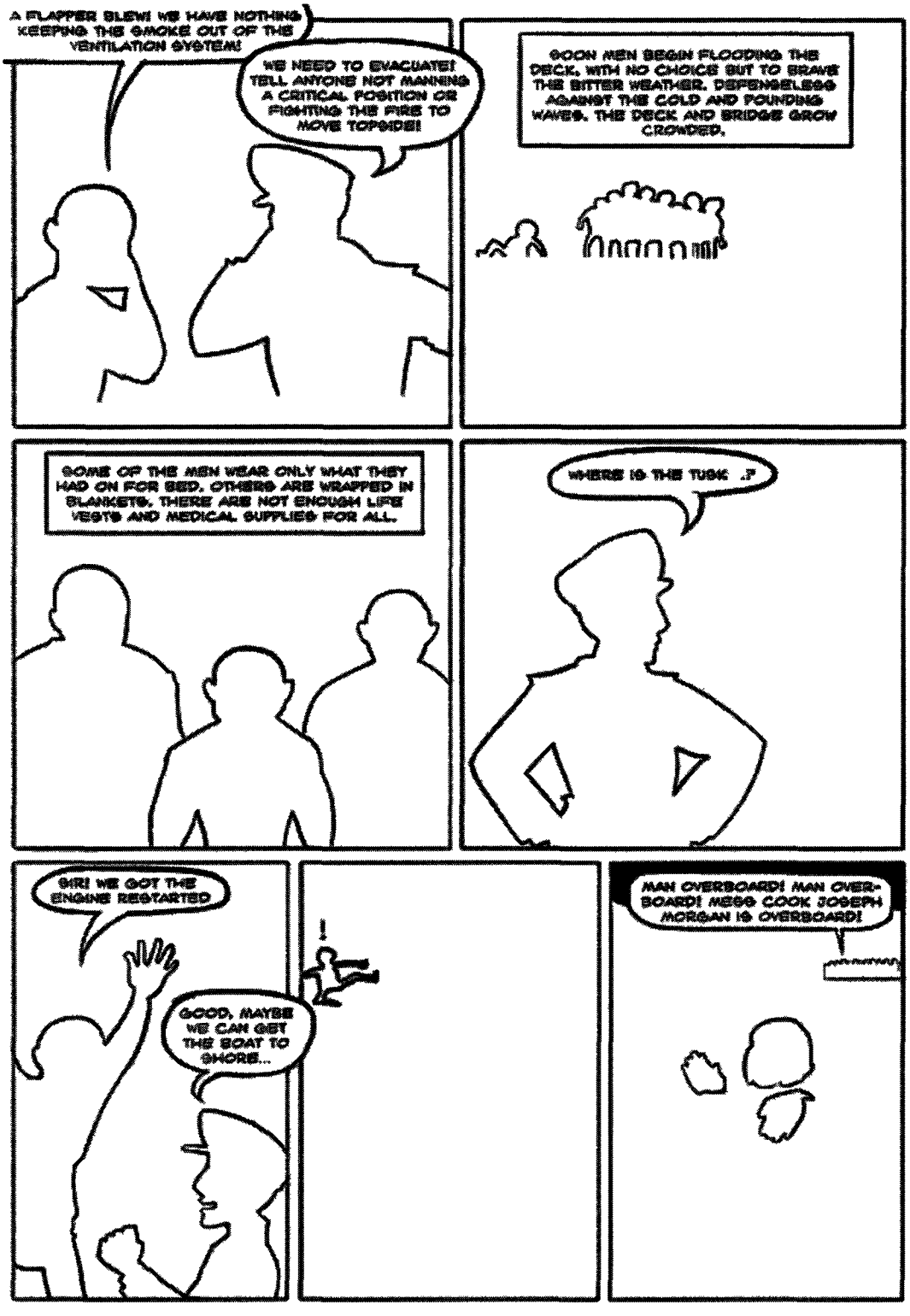
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SCENARIO 2

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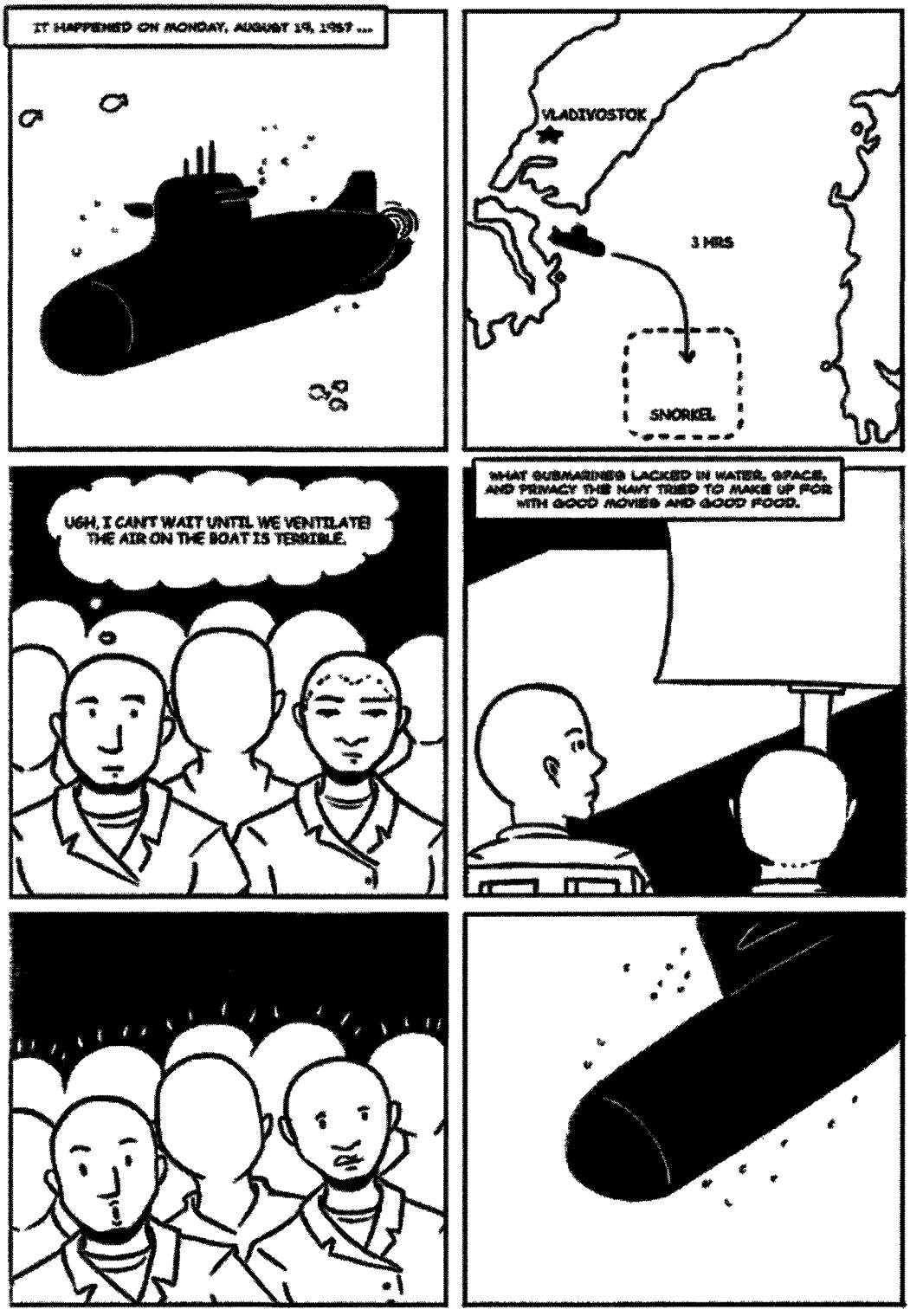

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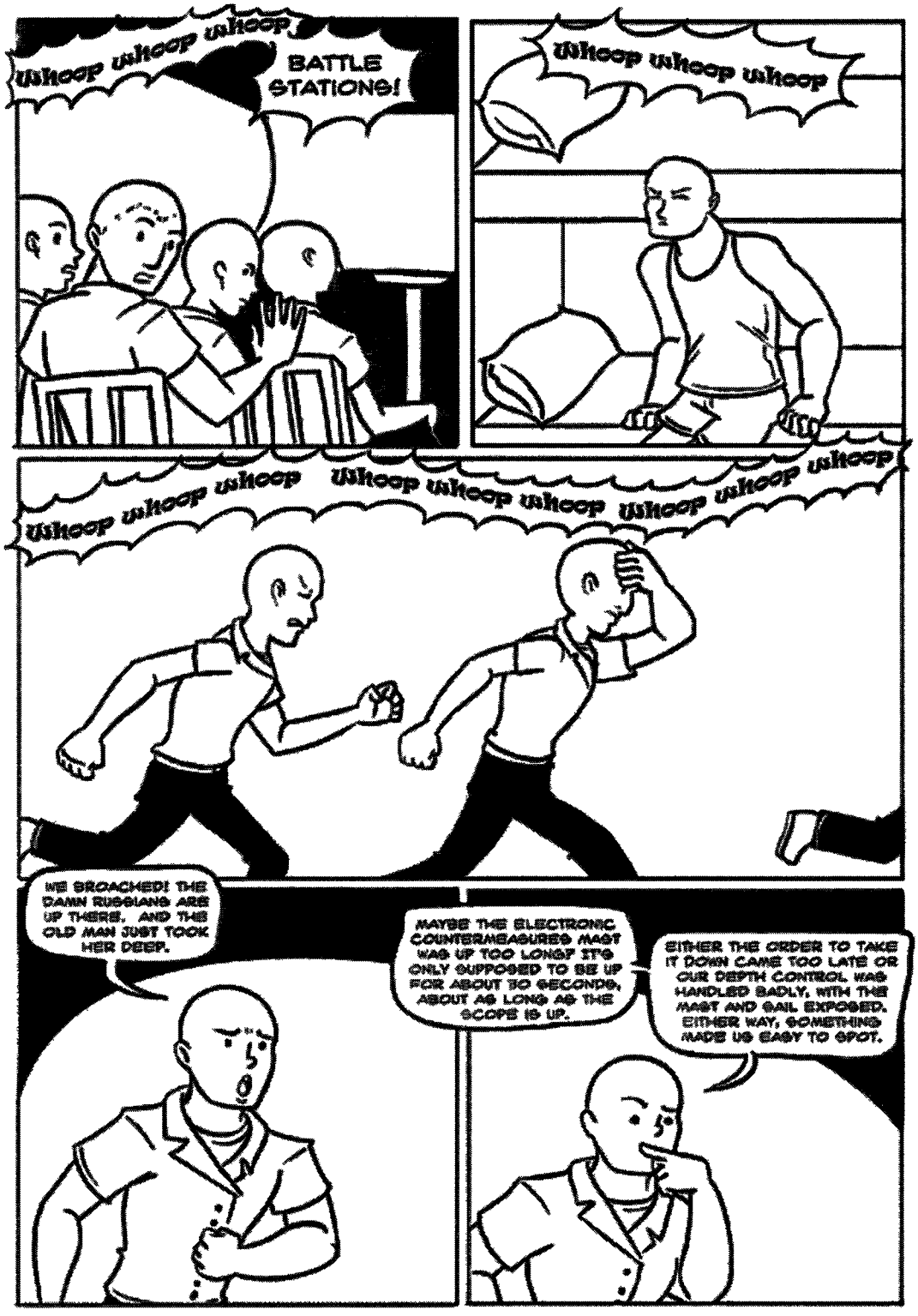
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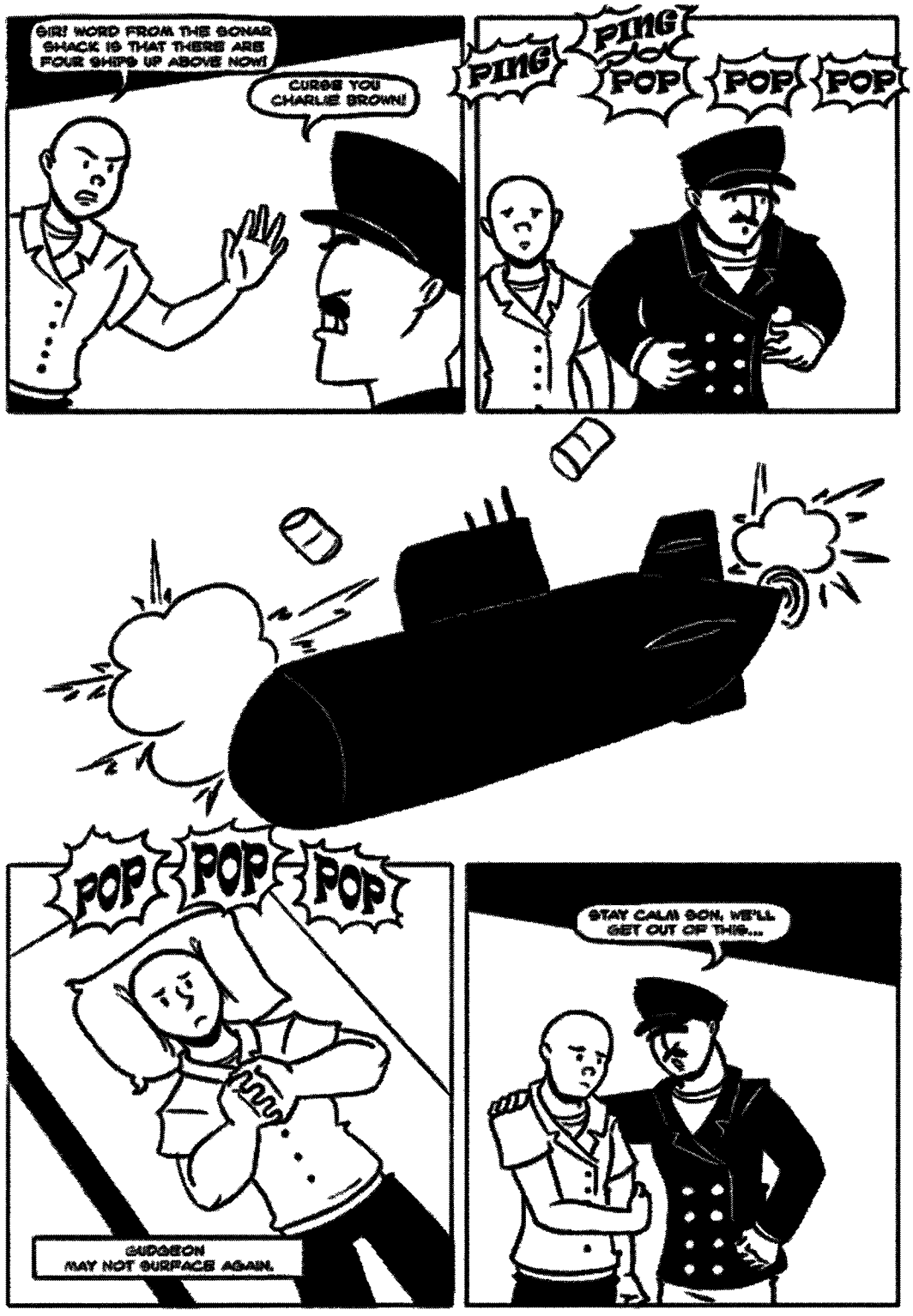
BATTLE STATIONS!
Whoop Whoop Whoop
Whoop Whoop Whoop Whoop Whoop Whoop Whoop Whoop Whoop
WE BROACHED! THE DAMN RUSSIANS ARE UP THERE. AND THE OLD MAN JUST TOOK HER DEEP.
MAYBE THE ELECTRONIC COUNTERMEASURES MAST WAS UP TOO LONG? IT'S ONLY SUPPOSED TO BE UP FOR ABOUT 30 SECONDS, ABOUT AS LONG AS THE SCOPE IS UP.
EITHER THE ORDER TO TAKE IT DOWN CAME TOO LATE OR OUR DEPTH CONTROL WAS HANDLED BADLY, WITH THE MAST AND SAIL EXPOSED. EITHER WAY, SOMETHING MADE US EASY TO SPOT.

Page 3 of 5


TAKE US DEEP! IF WE CAN FIND A TEMPERATURE LAYER, THE MASS OF COLD WATER WILL REFLECT THE SONAR PINGS BACK TO THE SHIPS SENDING THEM OUT. THE SOVIETS HAVE NO REASON TO USE PASSIVE SONAR, THEY'RE NOT THE ONES BEING HUNTED!
PING
PING
PING
PING
WE'VE BEEN ZEROED IN ON! FIRE CONTROL, PREPARE TO FIRE WEAPONS IF NECESSARY! QUARTERMASTERS, PLOT A COURSE THAT WILL ALLOW US TO ELUDE OUR PURSUERS.
BATTERIES ARE LOW, CARBON DIOXIDE LEVELS ARE HIGH. THERE'S NO WAY WE CAN SURFACE LONG ENOUGH TO CLEAR THE AIR OR RECHARGE. WE GOT CAUGHT AT THE WORST TIME.
TURN OFF ALL NON-ESSENTIAL FUNCTIONS TO CONSERVE POWER! GO TO RELAXED BATTLE STATIONS. ALL NON-ESSENTIAL CREW ARE TO RETURN TO THEIR BUNKS TO CONSERVE OXYGEN!

Page 4 of 5


SIR! WORD FROM THE SONAR SHACK IS THAT THERE ARE FOUR SHIPS UP ABOVE NOW!
CURSE YOU CHARLIE BROWN!
PING
PING
POP
POP
POP
POP
POP
POP
GUDGEON MAY NOT SURFACE AGAIN.
STAY CALM SON, WE'LL GET OUT OF THIS...

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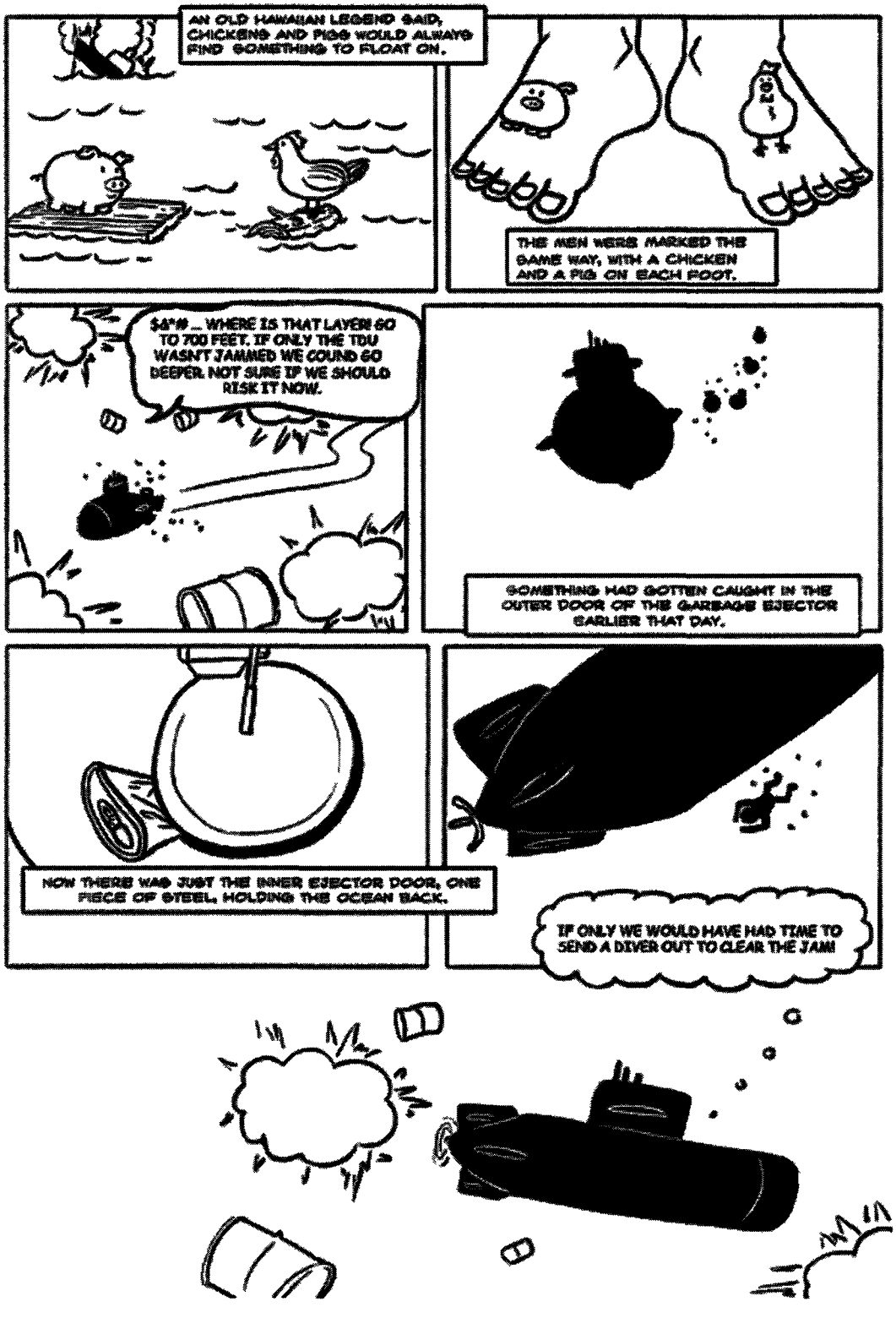

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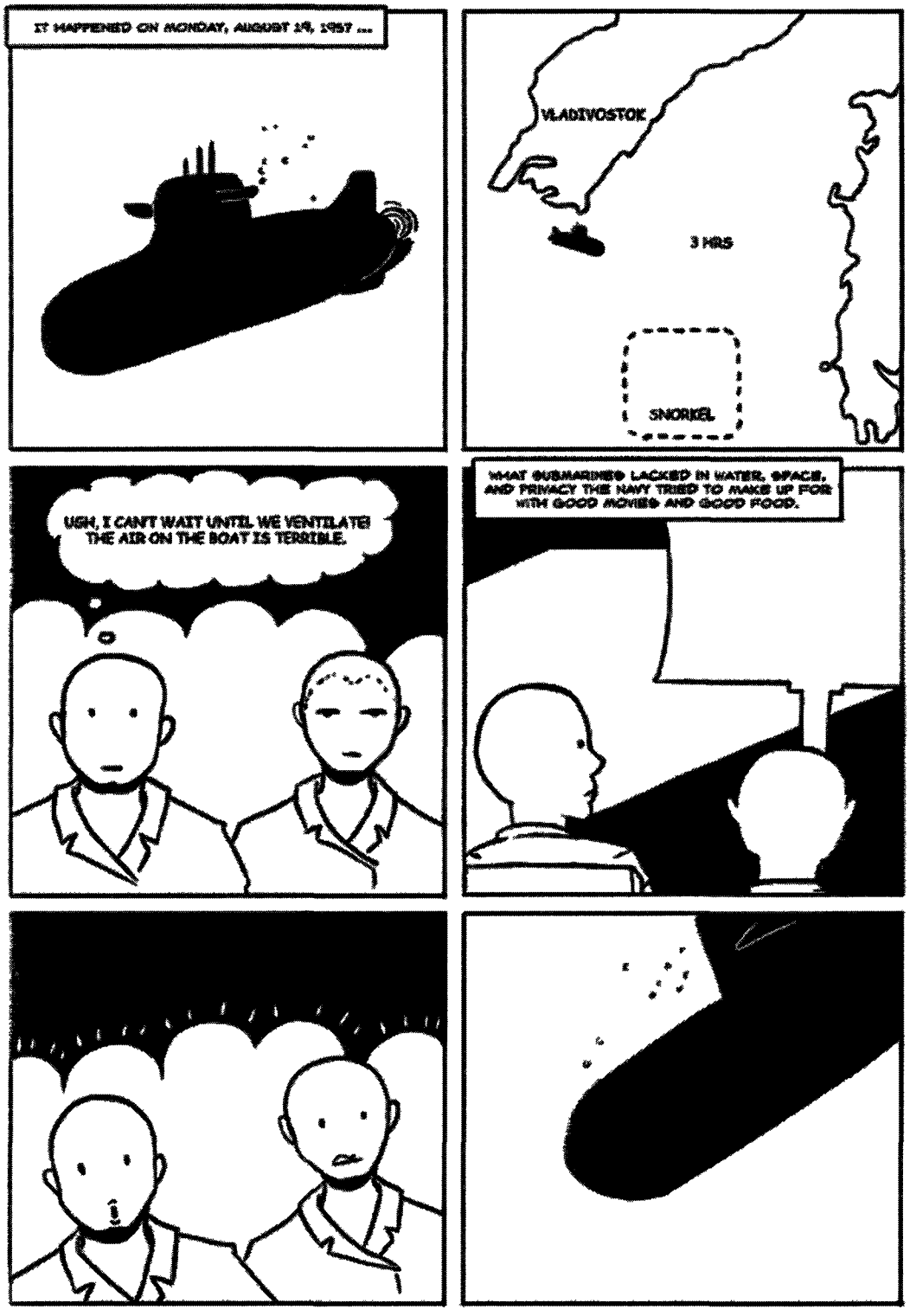

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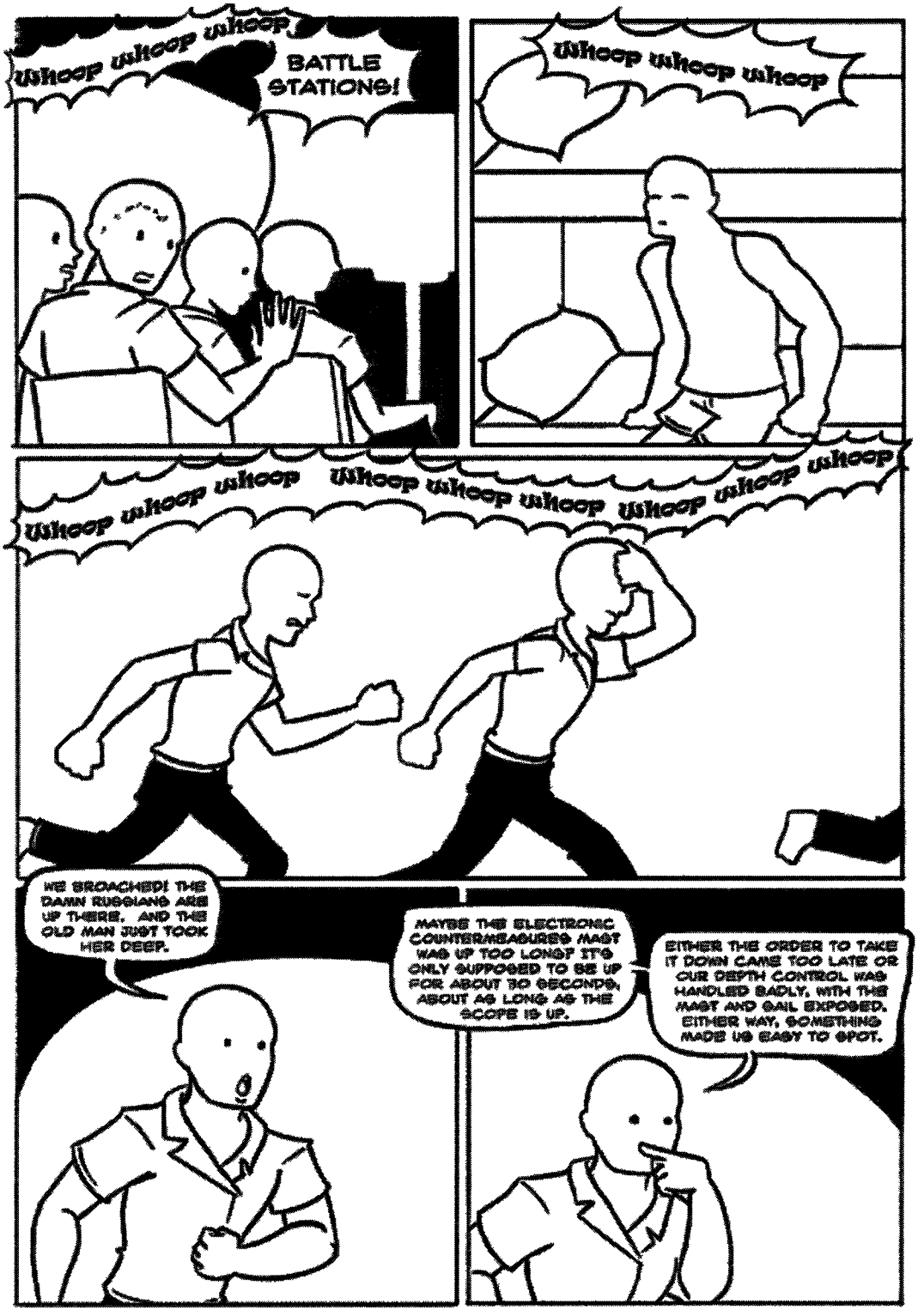
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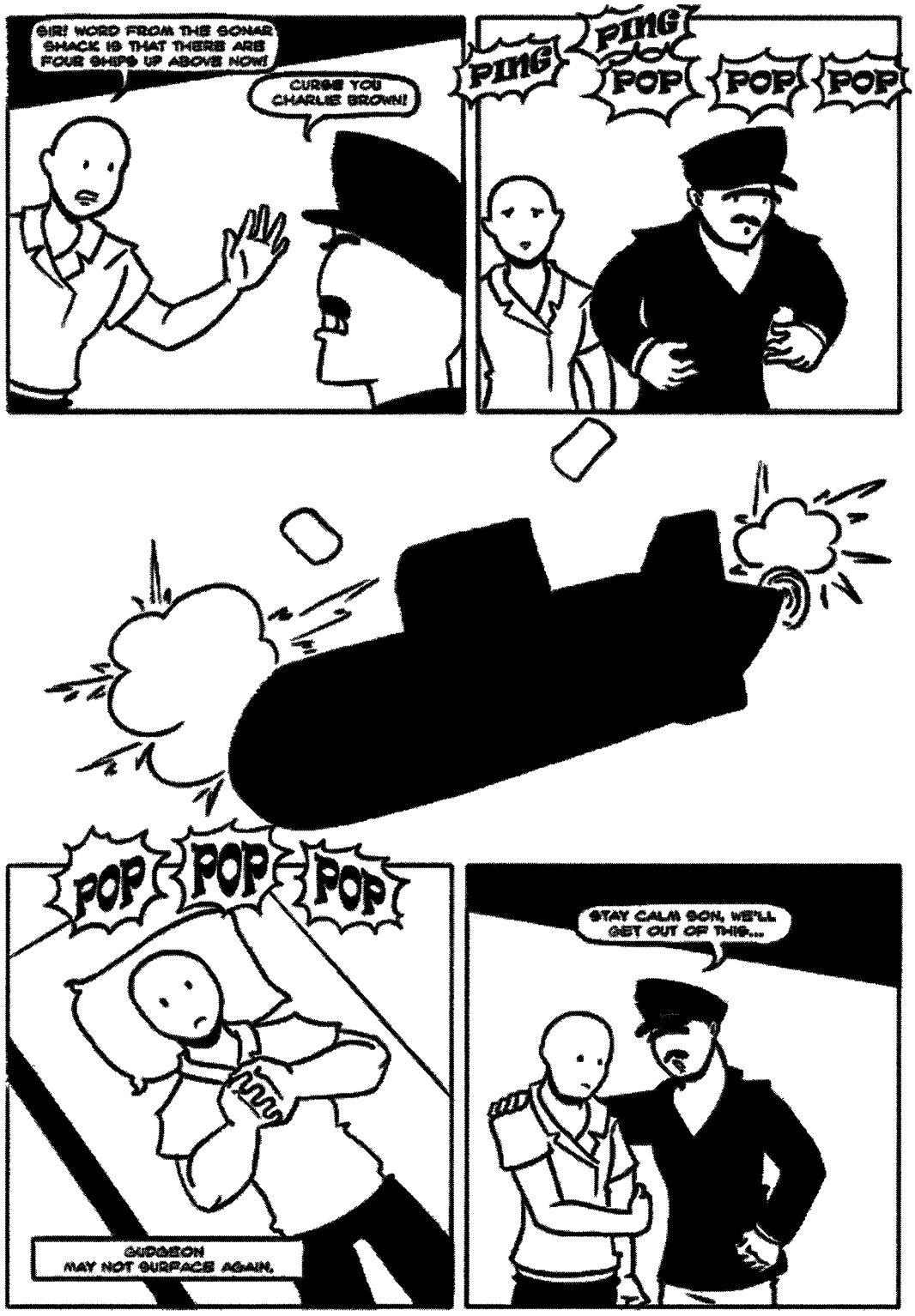
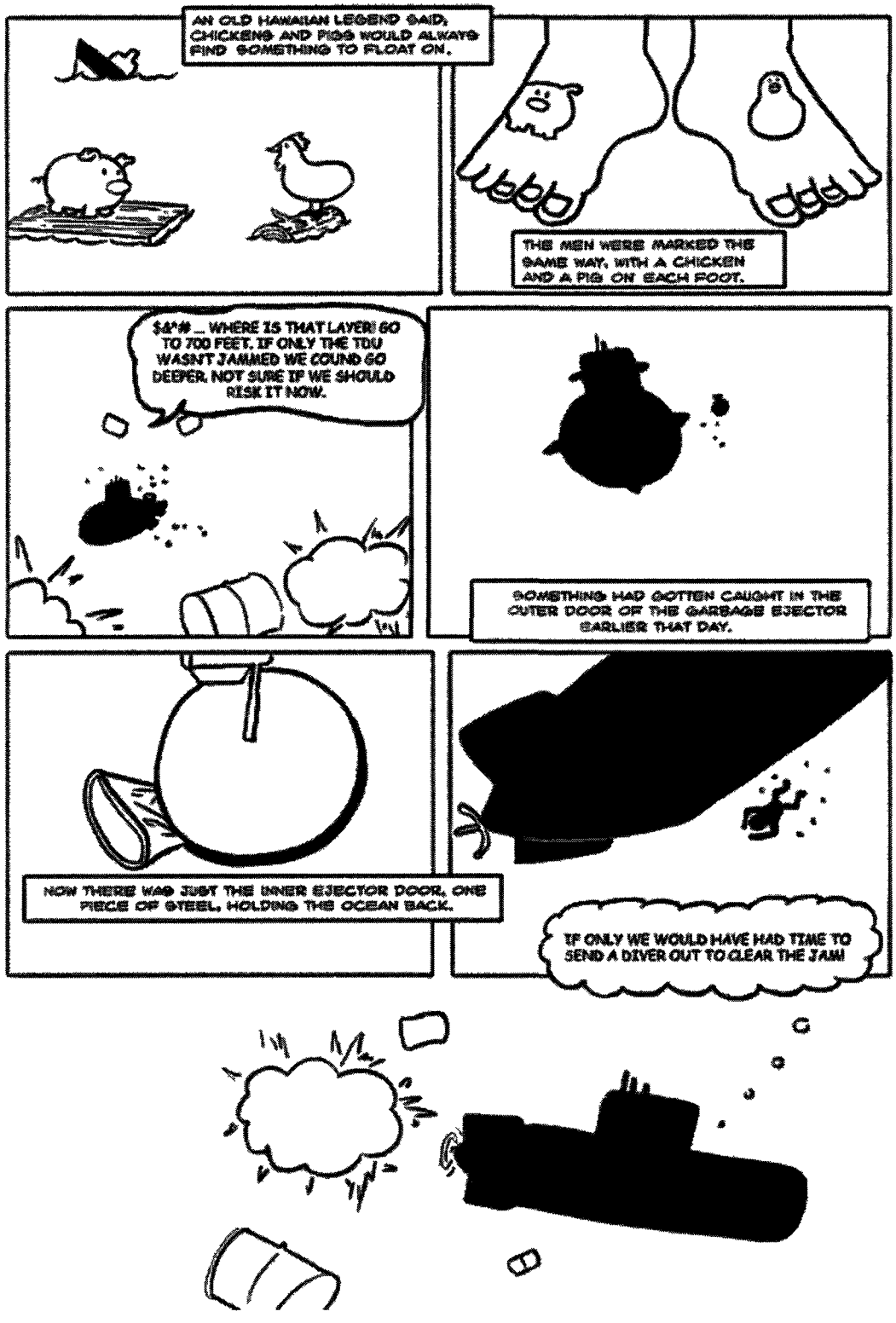
TURN OFF ALL NON-ESSENTIAL FUNCTIONS TO CONSERVE POWER! GO TO RELAXED BATTLE STATIONS. ALL NON-ESSENTIAL CREW ARE TO RETURN TO THEIR BUNKS TO CONSERVE OXYGEN!

Page 4 of 5_HD

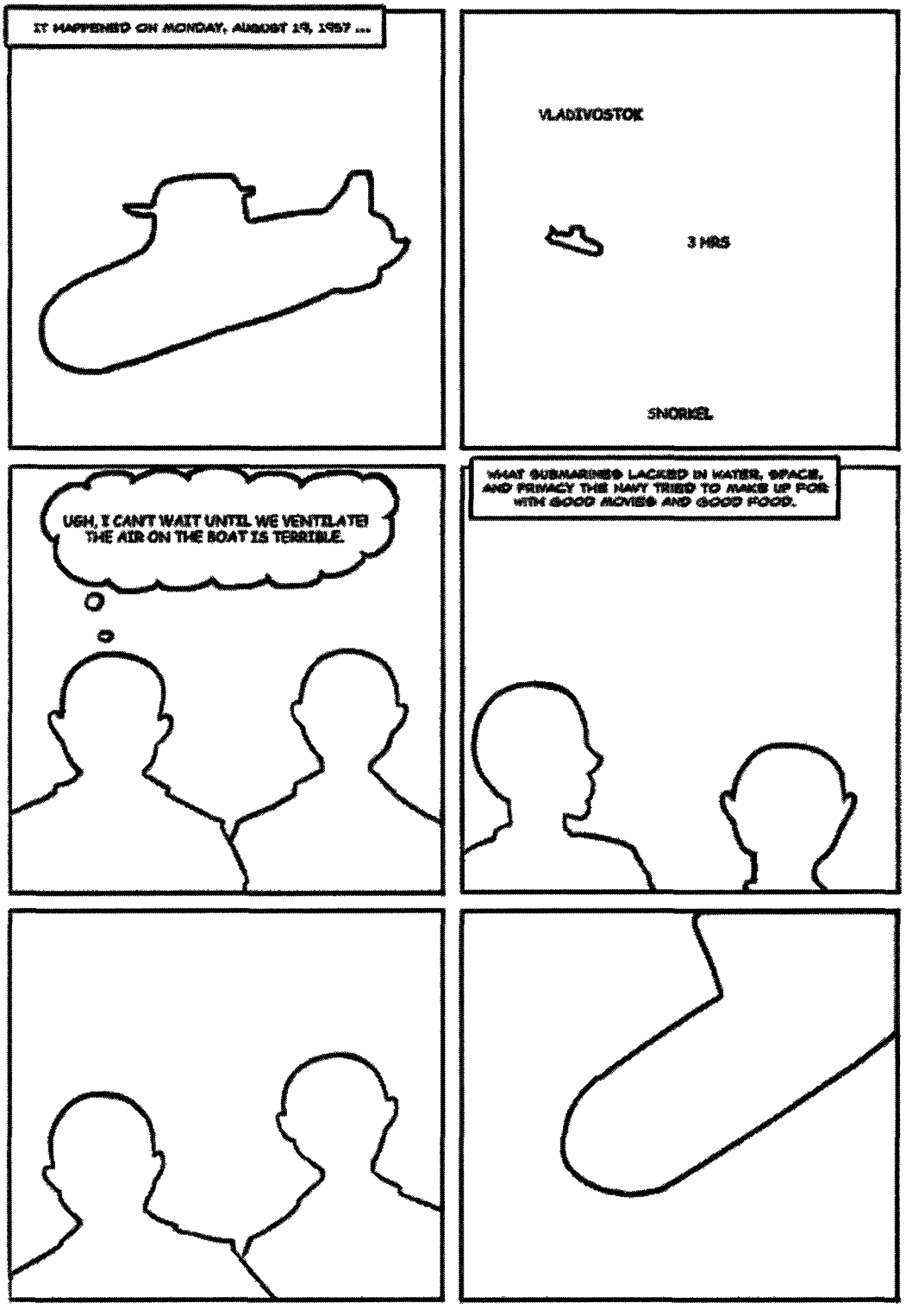

SIR! WORD FROM THE SONAR SHACK IS THAT THERE ARE FOUR SHIPS UP ABOVE NOW!
CURSE YOU CHARLIE BROWN!
PING
PING
POP
POP
POP
POP
POP
POP
GUDGEON MAY NOT SURFACE AGAIN.
STAY CALM SON, WE'LL GET OUT OF THIS...

Page 5 of 5_HD

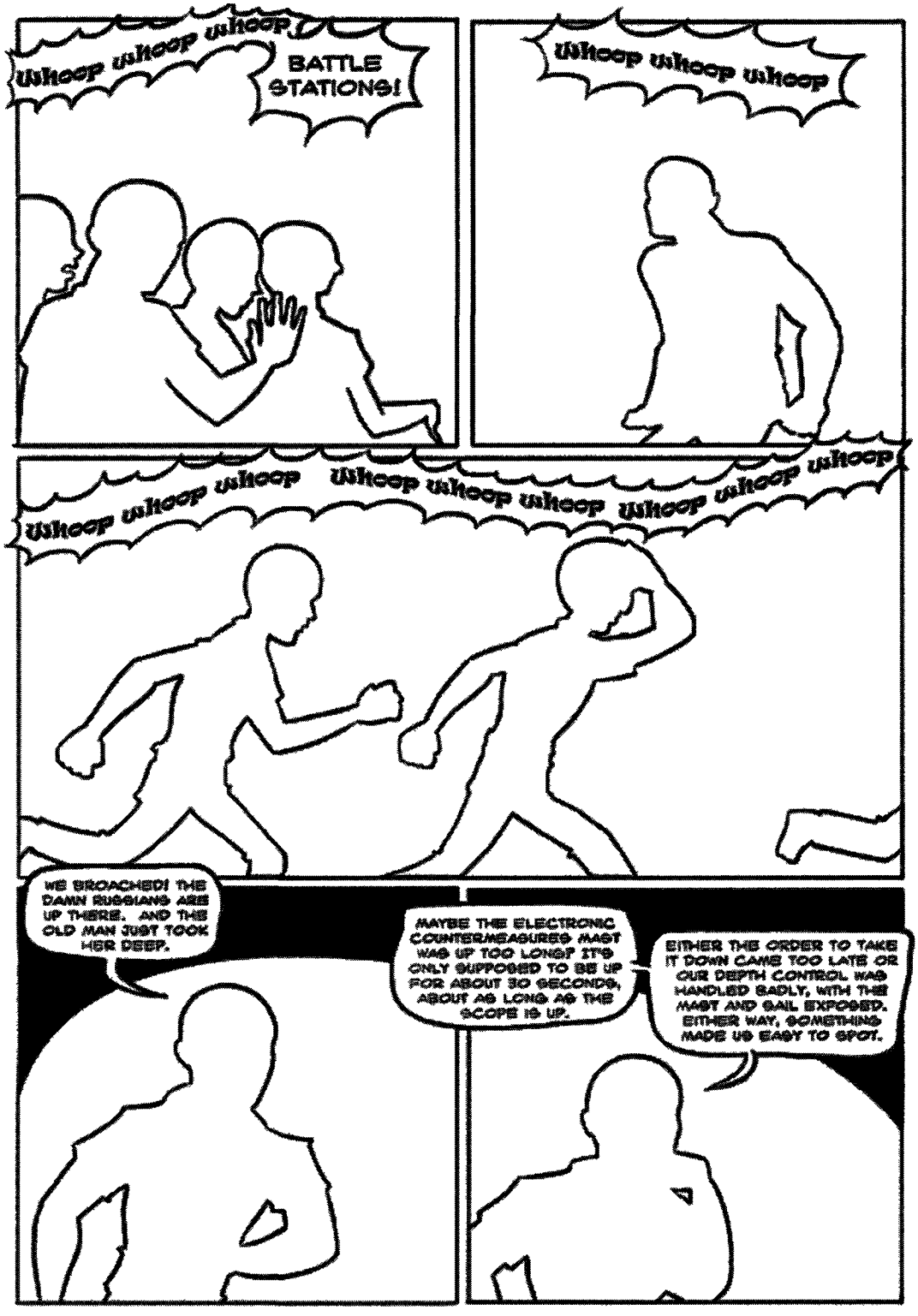

AN OLD HAWAIIAN LEGEND SAID, CHICKENS AND PIGS WOULD ALWAYS FIND SOMETHING TO FLOAT ON.
THE MEN WERE MARKED THE SAME WAY, WITH A CHICKEN AND A PIG ON EACH FOOT.
$&*# ... WHERE IS THAT LAYER! GO TO 700 FEET. IF ONLY THE TDU WASN'T JAMMED WE COUND GO DEEPER. NOT SURE IF WE SHOULD RISK IT NOW.
SOMETHING HAD GOTTEN CAUGHT IN THE OUTER DOOR OF THE GARBAGE EJECTOR EARLIER THAT DAY.
NOW THERE WAS JUST THE INNER EJECTOR DOOR, ONE PIECE OF STEEL, HOLDING THE OCEAN BACK.
IF ONLY WE WOULD HAVE HAD TIME TO SEND A DIVER OUT TO CLEAR THE JAM!

SCENARIO 2 NO DETAIL

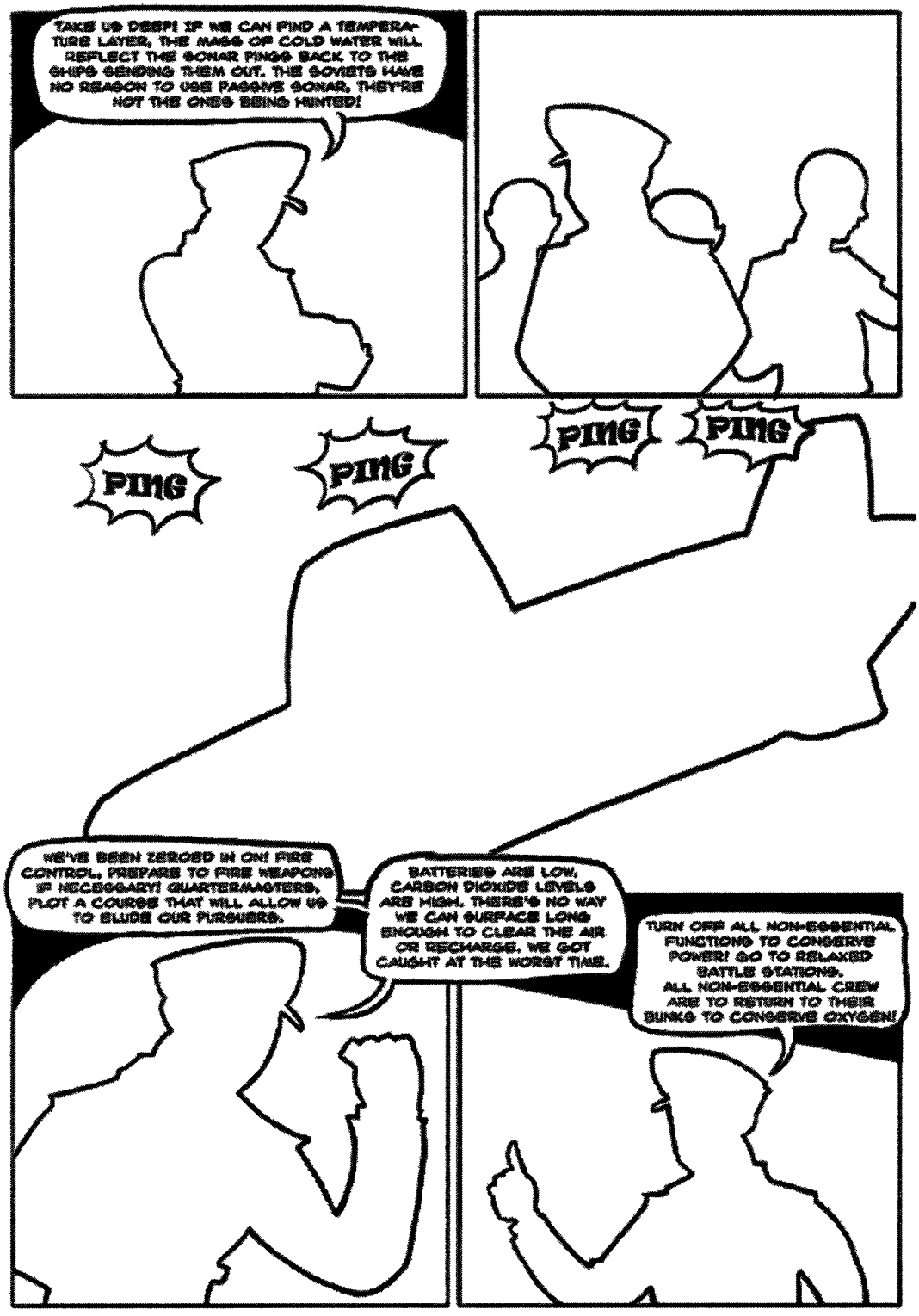
Page 1 of 5_ND



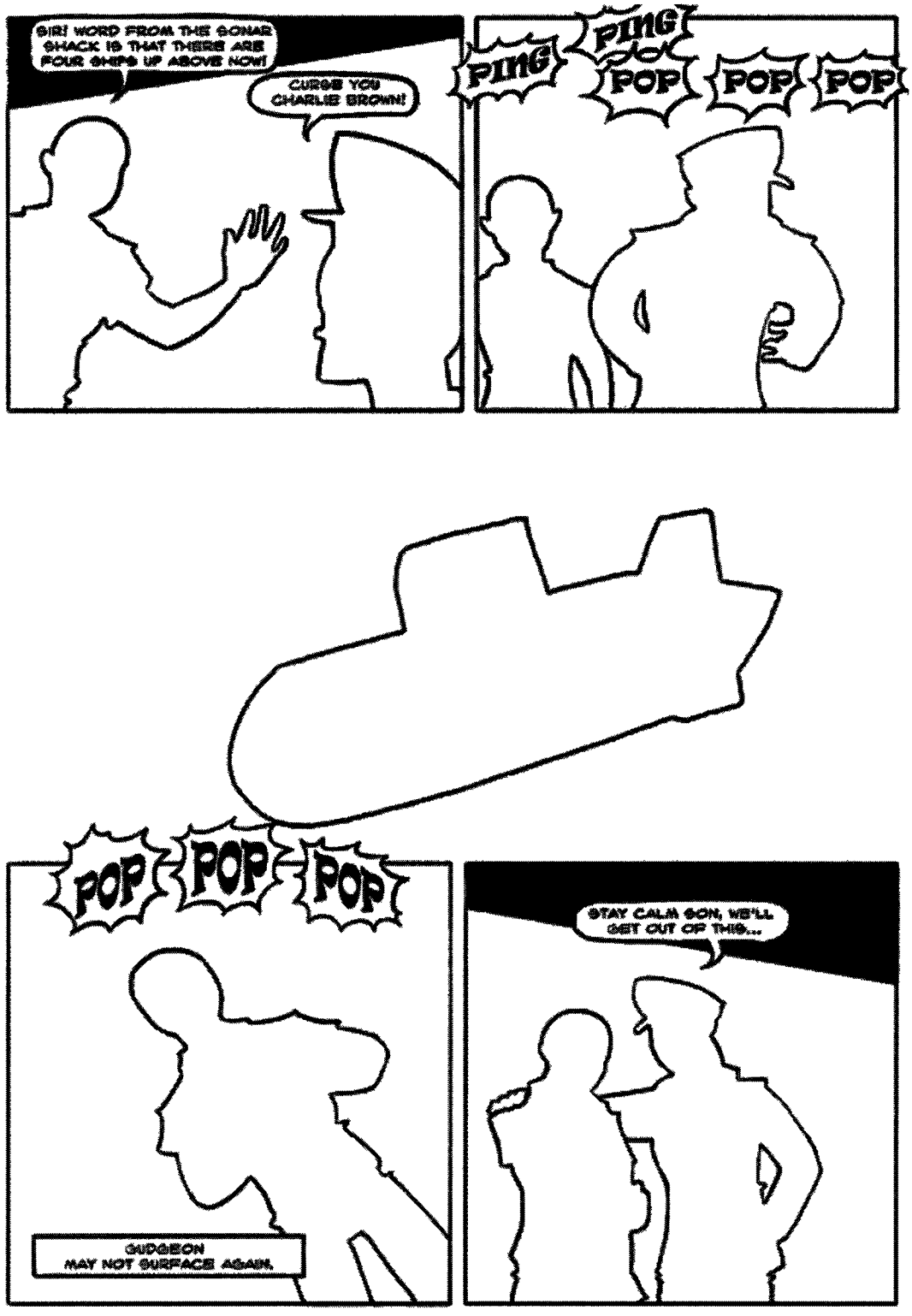
Page 2 of 5_ND


Whoop Whoop Whoop
BATTLE STATIONS!
Whoop Whoop Whoop
Whoop Whoop Whoop Whoop Whoop Whoop Whoop Whoop Whoop
WE BROACHED! THE DAMN RUSSIANS ARE UP THERE. AND THE OLD MAN JUST TOOK HER DEEP.
MAYBE THE ELECTRONIC COUNTERMEASURES MAST WAS UP TOO LONG? IT'S ONLY SUPPOSED TO BE UP FOR ABOUT 30 SECONDS, ABOUT AS LONG AS THE SCOPE IS UP.
EITHER THE ORDER TO TAKE IT DOWN CAME TOO LATE OR OUR DEPTH CONTROL WAS HANDLED BADLY, WITH THE MAST AND SAIL EXPOSED. EITHER WAY, SOMETHING MADE US EASY TO SPOT.

Page 3 of 5_ND


TAKE US DEEP! IF WE CAN FIND A TEMPERATURE LAYER, THE MASS OF COLD WATER WILL REFLECT THE SONAR PINGS BACK TO THE SHIPS SENDING THEM OUT. THE SOVIETS HAVE NO REASON TO USE PASSIVE SONAR, THEY'RE NOT THE ONES BEING HUNTED!
PING
PING
PING
PING
WE'VE BEEN ZEROED IN ON! FIRE CONTROL, PREPARE TO FIRE WEAPONS IF NECESSARY! QUARTERMASTERS, PLOT A COURSE THAT WILL ALLOW US TO ELUDE OUR PURSUERS.
BATTERIES ARE LOW, CARBON DIOXIDE LEVELS ARE HIGH. THERE'S NO WAY WE CAN SURFACE LONG ENOUGH TO CLEAR THE AIR OR RECHARGE. WE GOT CAUGHT AT THE WORST TIME.
TURN OFF ALL NON-ESSENTIAL FUNCTIONS TO CONSERVE POWER! GO TO RELAXED BATTLE STATIONS. ALL NON-ESSENTIAL CREW ARE TO RETURN TO THEIR BUNKS TO CONSERVE OXYGEN!

Page 4 of 5_ND


SIR! WORD FROM THE SONAR SHACK IS THAT THERE ARE FOUR SHIPS UP ABOVE NOW!
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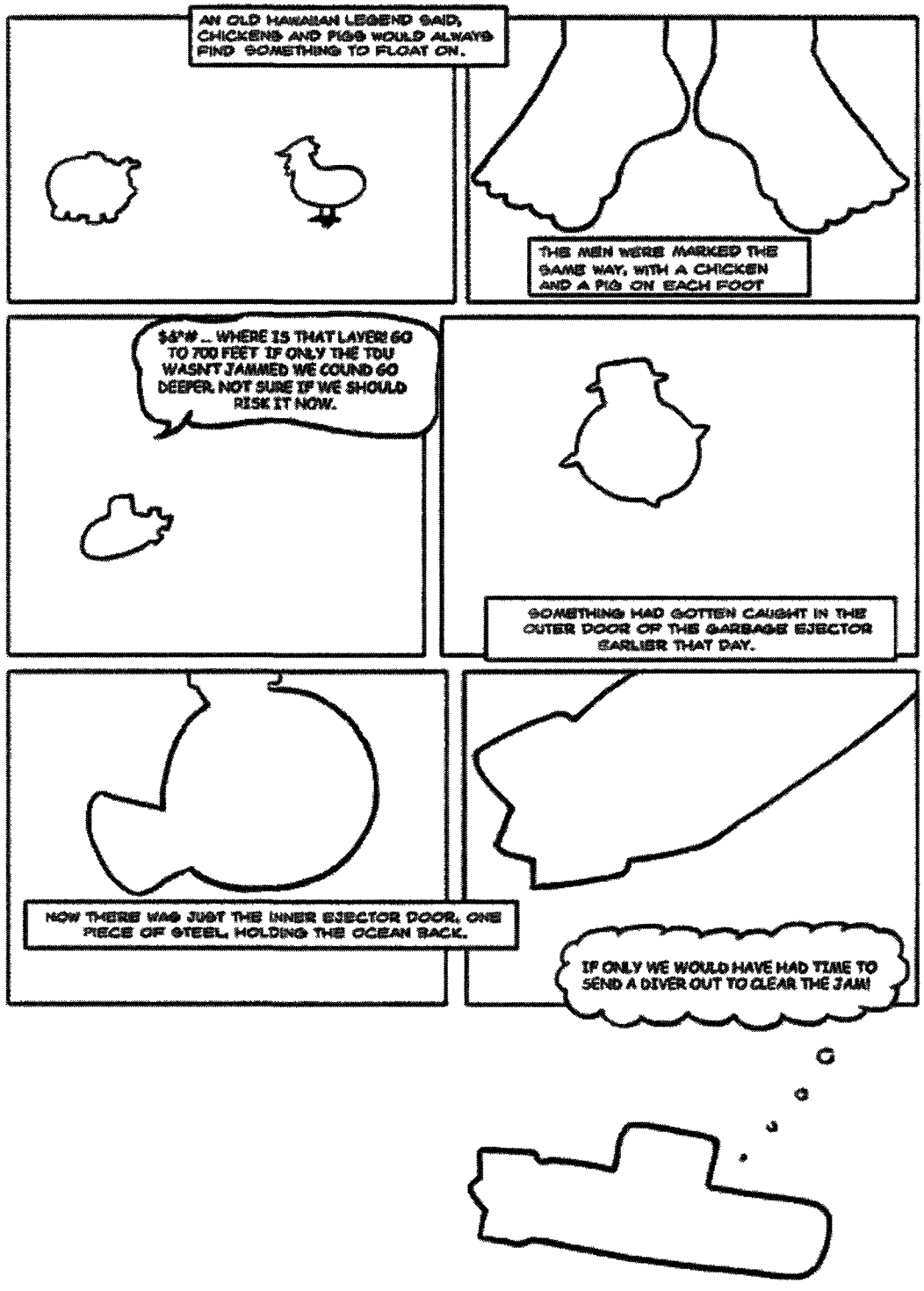
Page 5 of 5_ND


AN OLD HAWAIIAN LEGEND SAID, CHICKENS AND PIGS WOULD ALWAYS FIND SOMETHING TO FLOAT ON.
THE MEN WERE MARKED THE SAME WAY, WITH A CHICKEN AND A PIG ON EACH FOOT
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NOW THERE WAS JUST THE INNER EJECTOR DOOR, ONE PIECE OF STEEL, HOLDING THE OCEAN BACK.
IF ONLY WE WOULD HAVE HAD TIME TO SEND A DIVER OUT TO CLEAR THE JAM!

APPENDIX C

INFORMED CONSENT FORM WAIVER

TO: James Bliss, PhD
Responsible Project Investigator

FROM: George Maihafer, PT, PhD
Chairperson, IRB

RE: Addendum Request to "Comics as a Cognitive Training Medium for Expert Decision Making" (ODU IRB # 10 - 006

DATE: February 19, 2010

I approve the following change in an expedited review manner. The amendment to the methodology of the study is as follows:

- The waiver for participants' signatures on the informed consent form is granted in order to protect the identity of participants. It is understood that, after the purpose and intent of the study is presented to the potential sample population in classrooms or via fliers, that study subjects interested in participating will voluntarily seek out the investigators for participation.
- The Background questionnaire content is altered to protect the identity of participants – segmented age groups and ranks.

A Progress report or Close out Report will still be required at the January 2011 IRB meeting, based upon the original approval of one year for this study.

Please let me know if I can be of any further assistance.

TO James Bliss, PhD
Responsible Project Investigator

FROM: George Mahafer, PT, PhD
Chairperson, IRB

RE. Addendum Request to "Comics as a Cognitive Training Medium for Expert Decision Making" (ODU IRB # 10 - 006

DATE: February 19, 2010

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A Progress report or Close out Report will still be required at the January 2011 IRB meeting, based upon the original approval of one year for this study

Please let me know if I can be of any further assistance.

Appendix A

Informed Consent Form

OLD DOMINION UNIVERSITY

PROJECT TITLE. Comics as a Cognitive Training Medium for Expert Decision Making

INTRODUCTION
The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES

Comics as a Cognitive Training Medium for Expert Decision Making
Research will be conducted at:
Naval Base, Pearl Harbor
Pearl Harbor, HI 96860

RESEARCHERS
Responsible Principal Investigator
James P. Bliss, Ph.D
Associate Professor, Psychology
College of Sciences
Department of Psychology

Investigator
Amber Nalu, M.A. ABD
College of Sciences
Department of Psychology, Human Factors

DESCRIPTION OF RESEARCH STUDY
Several studies have examined expert decision making in a military setting. None of them have explained the effects of a comic training medium on the speed, accuracy, and quality of expert decision making performance in a military setting. This study will examine the use of comics as an alternative to current cognitive training media used by the military.

You will be asked questions pertaining to the length of time you've served in the military, your leadership roles, and decision making training (if any). Scenarios provided through text or comic media will pertain to submarine officer duties, or other required knowledge for your job aboard a submarine. After viewing the scenarios, you will be asked eight questions about your ability to process the information in the scenario such as detection of contradictory information or noting important information. Your argumentation skills will also be assessed by your ability to explain the information you've processed in the scenario. Questions such as, "What could be happening ", and, " ,what should you do?" require you to analyze the situation and make decisions based on the limited information provided. Further questions require you to determine the actions necessary to complete your plan of action and alternative plans, if any.

If you decide to participate, you will be shown a text-based medium or comic strip and then asked to answer a series of questions. If you say YES, then your participation will last for approximately 30 minutes at the Naval Base in Pearl Harbor, HI 96860. Approximately 63 submariner officers from ranks O-1 to O-4 in the U.S. Navy will participate in this study.

EXCLUSIONARY CRITERIA
All participants will be male submariner officers, ranks O-1 to O-4, in the U.S. Navy, and their ages will range from 18-59. Anyone who does not meet these requirements will be excluded from participating in this study.

RISKS AND BENEFITS
RISKS: None
BENEFITS: Although there are no direct benefits associated with your participation, your participation may lead to the improvement of military training materials and procedures.

COSTS AND PAYMENTS
The researchers are unable to give you any compensation for participating in this study.

NEW INFORMATION
If the researchers become aware of new information during this study that could reasonably change your decision to

participate, then this information will be shared with you

CONFIDENTIALITY
The researchers will take reasonable steps to keep private information, such as that provided in response to questionnaires, confidential. Specifically, a participant's name will not be directly associated with his results from the study. Each participant will sign this Informed Consent form and his participation in the study will be known. However a numbering system for participation will be used so that there will be no correlation between his name and his test results. The researcher will not ask for the name of participants' affiliated military submarines. The results of this study may be used in reports, presentations, and publications, but the researcher will not identify you. Although unlikely given the nature of this study, legally, your records may be subpoenaed by court order or inspected by government bodies with oversight or regulatory authority. The Department of Defense does not have regulatory authority.

WITHDRAWAL PRIVILEGE
It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and withdraw from the study at any time. Your decision will not affect your relationship with Old Dominion University, or otherwise cause a loss of benefits to which you might otherwise be entitled.

COMPENSATION FOR ILLNESS AND INJURY
If you say YES, your consent in this document does not waive any of your legal rights. However, in the event of injury arising from this study, neither Old Dominion University nor the researchers will be held liable for such injury. In the event that you suffer injury as a result of participation in any research project, you may contact the responsible principal investigator, Dr. James P. Bliss (information listed below) or the investigator, Amber Nalu, (information listed below). You may also contact Dr. George Maihafer, the current IRB chair at Old Dominion University at (757) 683-4520, or the Office of Research at (757) 683-3460.

VOLUNTARY CONSENT
By signing this form, you acknowledge that you have read this form or have had it read to you, and that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, please direct them to:

Responsible Principal Investigator:
James P. Bliss, Ph.D.
Associate Professor, Psychology
College of Sciences
Department of Psychology
(757) 683-4051

Investigator:
Amber Nalu, M.A., ABD
College of Sciences
Department of Psychology, Human Factors
(619) 851-2792

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, please contact Dr. George Maihafer, the current IRB chair, at 757-683-4520, or the Old Dominion University Office of Research at 757-683-3460.

Most importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher will give you a copy of this form for your records.

INVESTIGATOR'S STATEMENT
I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent

IRB Identifier:_____
(To Be Assigned by the IRB)

form

Investigator's Printed Name & Signature	Date

Approved Institutional
Review Board - ODU

JAN 2 1 RECD 2010

Expires 1 year from date
Questions: 757-683-3460

No.: 10 - 006

OLD DOMINION UNIVERSITY
HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD
RESEARCH PROPOSAL REVIEW NOTIFICATION FORM

TO: James Bliss
Responsible Project Investigator

DATE: January 21, 2010
IRB Decision Date

RE: **Comics as a Cognitive Training Medium for Expert Decision Making**
Name of Project

Please be informed that your research protocol has received approval by the Institutional Review Board. Your research protocol is:

___ Approved
___ Tabled/Disapproved
_X__ Approved, contingent on making the changes below*

IRB Chairperson's Signature

January 21, 2010
Date

Contact the IRB for clarification of the terms of your research, or if you wish to make ANY change to your research protocol.

The approval expires one year from the IRB decision date. You must submit a Progress Report and seek re-approval if you wish to continue data collection or analysis beyond that date, or a Close-out report. You must report adverse events experienced by subjects to the IRB chair in a timely manner (see university policy).

---

* Approval of your research is CONTINGENT upon the satisfactory completion of the following changes and attestation to those changes by the chairperson of the Institutional Review Board. Research may not begin until after this attestation.

*** In the Application**

- **Under 11, remove the statements that address data analysis methods and replace them with a more detailed description that describes the questions that are being asked of the participants as well as the task scenarios and scripts that will be employed**

In the Informed Consent

- **Under Description of Research Study, provide a few sentences that will give the potential subjects information about what questions will be asked and what scenarios may be encountered in the project.**

- The investigators may wish to remove the risk of "hand cramping" in the risks and benefits section. This request is not mandatory and is left to the discretion of the researchers.
- Under Compensation for Illness and Injury, add the Office of Research and phone number (757) 683-3460 as a point of possible contact.
- Dr. Rubenstein reminded the investigators that The Office of Research will need to receive written notification of approval when that occurs with the Navy IRB/Human Subjects Review Board

Attestation

As directed by the Institutional Review Board, the Responsible Project Investigator made the above changes. Research may begin.

_____ **February 19, 2010**

IRB Chairperson's Signature *Date*

APPENDIX D

GENERAL INFORMATION

The study that you will be participating in is a decision making task You will be shown either a comic strip or text-based media To begin, please fill out the information below Thank you for your participation

Age (please check one) ___18 – 29 ___30 – 39 ___ 40 – 49 ___50-59 ___60-69

Rank (please check one) _____O-1 to O-2 _____ O-3 to O-4

Number of months / years served in the military _____

Number of months / years in a leadership role _____

Number of months / years served on a submarine _____

Number of months / years working as a division officer and/or department head _____

Have you had any training with regard to leadership decision making? (circle one) Y N

If yes, how many months / years did you train for leadership decision making? _____

If yes, what type of training did you receive? _____

APPENDIX E

INSTRUCTIONS

You will be given 10 minutes to read the provided material The experimenter will then hand you 8 Decision Sheets faced down with one question per sheet The researcher will tell you to turn the first question sheet face up and begin writing When you are finished writing the first question, turn it face down and turn the second sheet face up Repeat this process until all 8 sheets have been answered Please answer as completely, accurately, and as quickly as possible Your responses are anonymous Thank you for your participation

APPENDIX F

DECISION SHEET

Please answer the questions below as accurately, as detailed, and as quickly as possible

Information Processing

1 Please tell me what is happening in this scenario (Please explain)

2 Can you detect any incomplete or contradictory information? (Please explain)

3 Which information do you feel is most important in the scenario? (Please explain)

Argumentation

4 What could be happening with the incomplete or contradictory information you've discovered? (Please explain)

5 Are there alternative explanations for the incomplete or contradictory information? (Please explain)

6 Now that you have assessed the situation within the scenario, what should you, as the captain, do? (Please explain)

Results

7 Who would you, as the captain, communicate with and which actions would you take to complete your plan of action? (Please explain)

Contingency Plans

8 If your initial plan doesn't work, do you have alternative plans? (Please explain)

9 Did you like the comic (or text) that you previously viewed?

(Decision Sheet based on methods discussed by Van Den Bosch and De Beer (2003))

APPENDIX G

DEBRIEFING DOCUMENT

Dissertation Project Titled
Comics as a Cognitive Training Medium for Expert Decision Making

Amber Nalu
Old Dominion University

Thank you for participating in my dissertation project My hope is that your participation in this research will lead to the improvement of military training materials and procedures Other submarine officers may participate at a later time, so please do not share your experiences in this study with them By preventing exposure of experimental information to potential participants, my research will be more accurate and, ultimately, more helpful in determining which training materials work best for you Below are an abstract and a two page synopsis that briefly state the purpose and details of the study

If you have any questions, please direct them to

Responsible Principal Investigator
James P Bliss, Ph D
Associate Professor, Psychology
College of Sciences
Department of Psychology
757-683-4051

Investigator
Amber Nalu, M A , ABD
College of Sciences
Department of Psychology, Human Factors
(619) 851-2792

Old Dominion University Institutional Review Board chair
Dr George Maihafer
757-683-4520

Old Dominion University Office of Research
757-683-3460

Abstract

Experts such as military commanders must make decisions quickly and under deadly conditions A variety of cognitive training media exist, from Powerpoint to virtual reality (VR) simulations, however, there are alternative media that have not yet been comprehensively studied for expert decision making training In the proposed study, the

researcher will examine the use of comics as an alternative to current cognitive training media In Experiment 1, naval submariners will be shown a text-based medium or comic strip and asked to make a decision about the scenario after viewing The scenario will be derived from a situation that submariners are somewhat familiar with but cannot predict In Experiment 2, the level of symbolic abstraction will be manipulated across three separate comic strips Results should show that submariners' decision making ability scores are superior and response times are faster with comic media than text-based media Results should also show superior scores with lower levels of symbolic abstraction Given such results, comics should be used as an alternative to current cognitive training media because they can save money, are a universally understood media that can meet the needs of the diverse military population, and are effective for rapid and comprehensive soldier training

Two Page Synopsis
Comics as a Cognitive Training Medium for Expert Decision Making

The purpose of the current study is to determine how effective comics are when used as a cognitive training medium for expert decision making There are many different cognitive training media currently in use, from traditional text-based media to virtual reality based simulations The current project will examine why comics should be used for cognitive training Concepts utilized in comics, such as image schema, will be defined and discussed with reference to a universal human language

Naturalistic Decision Making (NDM) will be discussed as a basis for the expert decision making task and critical-thinking training measures represent the basis for expert decision making abilities I hypothesize that expert decision making training using comics will result in superior performance scores than text-based media I also hypothesize that low levels of symbolic abstraction improve expert decision making abilities more than high levels of symbolic abstraction

Method

U S Navy submarine officers will participate in this study In Experiment 1, an operational scenario will be described using text or using comic panels Submarine officers will make a decision after viewing each media presentation In Experiment 2, the level of symbolic abstraction within comic panels will be manipulated Three groups of participants will view a low, medium, or high level of symbolic abstraction within the comic presentation Participants will make a decision after viewing the media presentation

Results

Results should show better decision making skills after cognitive training using a comic medium than after using a text-based medium Results should also show improved decision making abilities with low levels of symbolic abstraction within comic presentations In Experiment 1, an independent t-test will be performed to analyze submarine officer scores In Experiment 2, one-way between-subjects analyses of

variance (ANOVA) will be performed to analyze submarine officer scores Two Tukey HSD planned comparison tests will be performed with significant ANOVA results

Discussion

The use of comics to train decision making skills has a number of potential benefits for the military and other industries Improvements over current training media include reduced training development costs, flexible media format, and accessibility at home port or overseas Sensorimotor Contingency Theory (Noe & O'Regan, 2002), with its important connections to mental structures, namely image schemas (Mandler, 1992), supports the consideration of comics as an effective and efficient alternative to cognitive training media currently used in the military

APPENDIX H

RECRUITMENT PROCESS

The recruitment process will be as follows

- Amber Nalu will post flyers at the training school to recruit submarine officers The flyer is shown on page 2
- Amber Nalu will provide information to submarine officers in classrooms, when available, but will not run the experiment in the classroom The following script will be read

"Hello and good afternoon I appreciate your time, so will keep this as brief as possible My name is Amber Nalu and I am a researcher, pursuing the completion of my dissertation project through Old Dominion University as part of the requirement for receiving my Doctorate in Human Factors Psychology My research is focused on the use of comics as an alternative to current cognitive training media used by the military

You have been identified as a key research participant and your expert decision making performance will help me understand more about which training media works best for your training needs My hope is that your participation in this research will lead to the improvement of military training materials and procedures

I appreciate your willingness to participate and value your feedback Please note that your name and your affiliated military submarines will remain completely anonymous I will not identify you in any reports, presentations, or publications, and your responses will be kept completely confidential

Please contact me if you would like to participate, or if you have any questions or concerns about this study or my research My information is posted on the flyer outside the classroom Thank you "

Flyer

Improve Submarine Training Through Comics!

Help improve military training methods by participating in a 30 minute training study. You must be:

- A submarine officer
- Ranks O-1 to O-4

Your participation is completely anonymous and your name or boat will NOT be asked. If you are interested, please contact:

Amber Nalu

By email: ambernalu@gmail.com
or
By phone: (619) 851-2792

Thank you.

APPENDIX I

GRADING SHEETS

Scenario 1	
Question	**Answer**
1 Please tell me what is happening in this scenario	fire in battery water through snorkel mast Rough seas Man overboard EAB failure Evacuation of ship cochino in enemy waters cochino spying on soviets Subex with tusk Pressure seals battery door shut Forward battery powers aft battery Attempt to disconnect batttery Explosion Trying to detect telemetry signals Attempt to snorkel Ventilation flapper fails Engine restored cochino off coast of russia failed hydrogen detector
2 Can you detect any incomplete or contradictory information?	possible position of tusk engine restoration diesel boat scenario vague casualty plan Lack of coms vague scenario Log hitting periscope reason for intel / subex status of electric plant Disjointed scenario (first part doesn't seem to go along with second part) Uniforms Status of casualty Provisions topside Why hydrogen detector failed
3 Which information do you feel is most important in the scenario?	status of fire casualty outside environmental conditions MOB ship evacuation other ship location

	EAB failure visibility CO involvement DC efforts Safety Mission OPSEC chance of rescue possible comms hostile waters surfacing water through snorkle mast H2 detector malfunction explosion SUBEX Nature of data intercepted possibility of rescue
4 What could be happening with the incomplete or contradictory information you've discovered?	Lack of comms disorganized casualty response Reasons other sub is not present to help Possible head vavle damage deisel flooding Possible collision with other sub Possible loss of personnel Reasons for explosion exact location of fire Priorty of mission with respect to casualty Connection between first and second part of story Hostility of enemy possible counter-detection toxic atm head valve damage loss of personnel ship evaction lifevests
5 Are there alternative explanations for the incomplete or contradictory information?	lack of comms disorganized casualty response Reason other sub not present to help Surfacing allowed deisel restoration Not H2 explosion Depth when hitting log, size of boat when hitting log Decoy mission Focus of CO on mission caused problem buildup 2 separate stories

	Disatance from land prevented counterdetection Distance from land farther since SUBEX being conducted Use of UW comms to contact other sub
6 Now that you have assessed the situation within the scenario, what should you, as the captain, do?	Fight fire disconnect batteries cloth personnel topside Ventillate string EABs together disconnect battery contact other sub rescue MOB proceed to port Send people back in ship with EABs Keep personnel safe Continue evac send sitrep fire flares send distress message Send personnel back below establish comms go to international waters Prepare to abandon ship shoot flares 5 whistle blasts use UW telephone fully surface keep radio silence
7 Who would you, as the captain, communicate with and which actions would you take to complete your plan of action?	XO to disconnect battery and take charge below XO/ DCA for casualty control control to steer ship other ship for rescue radio for rescue Boss for SITREP MIC at sceen for casualty control eng for casualty status Nav for best course for land Deck div to help topside OOD to steer Rtp plan
8 If your initial plan doesn't work, do you have alternative plans?	Abandon ship get life vests try for rescue communicate with other sub

	Continue to fight fire disconnect batteries Drive ship to shallow water Contact anyone including russians for help proceed to allied country try to establish comms head to international water Fight casualty Send distress call to anyone Keep crew warm

Scenario 2	
Question	**Answer**
1 Please tell me what is happening in this scenario	In territorial waters Transiting to area to snorkle Counterdected Go deep to evade Try to find layer but can't Soviets drop small depth charges Can't go deeper due to TDU jam Batteries are low Chased by Soviets Soviets using active sonar Spying on Russia Go to relaxed battle stations Soviets attacking a ship
2 Can you detect any incomplete or contradictory information?	Reason for counterdetection unclear Reason within 12NM unclear Crew would not normally be watching movies within 12NM Time they can remain submerged is unknown Exact position of sub unknown TDU jam info is unclear Test depth control is unclear Battery management while on mission is unclear Why soviets are dropping depth charges is unclear Whether the ship broached or it was the mast is unclear Parameters of soviet active sonar is unclear Exact charge left on battery Current speed of sub is unknown,

	Intent of the soviets is unknown Political relationship between US and USSR unclear Layer and bottom depth unknown Should have most experienced personnel on watch Mission risk
3 Which information do you feel is most important in the scenario?	counterdetection enemy combattants use of active sonar Territorial waters need to snorkle crew readiness Levels of CO2 / O2 / Battery Location of layer TDU jam Life support on board Low battery sonar parameter use of depth charges Limitation in depth
4 What could be happening with the incomplete or contradictory information you've discovered?	The mission details CO decisions Going to PD in international waters TDU is really jammed The mast was left up too long Should have left earlier from area Possibly in area collecting important data In hostile area should have most experienced on watch High possibility for flooding Getting counterdetected by russian in territorial waters Cannot go deeper Soviets have solid contact Batteries are about to die Soviets are trying to sink sub Understanding of TDU system poor
5 Are there alternative explanations for the incomplete or contradictory information?	Risk mitigation for battery state poor Most experienced should have been on watch Specuations about going below test depth unclear Possibly russians are just playing war games and not attacking Soviets have lost contact Soviets are just trying to drive submarine

	away
6 Now that you have assessed the situation within the scenario, what should you, as the captain, do?	Escape via escape route Continue to evade Ventillate RFRE Post TDU watch Continue deeper to look for layer Continue out of territorial waters Wait for night Snorkle Send SITREP Fix TDU Put all non-essential crew in rack If necessary emergency surface and abandon ship Proceed outside 12NM Don't make torpedos ready due to noise Stay deep Proceed to PD ASAP Open distance to soviets Use counter measures Rig for quiet Stay at low speed Hover with only essential equipment
7 Who would you, as the captain, communicate with and which actions would you take to complete your plan of action?	Battery expert to extend battery life Corpman for air quality Navigation to find course away Only on board, non off hull All hands on board Increase atm sampling freq RFRE XO and Nav, DCLCPO for TDU problem Eng about the battery OOD to go deep OOD, XO, COB, DHs for plan Eng for battery status Weps if weapns necessary Cook to watch TDU The crew for morale Control Room to keep control of situation XO to ready watchstanders
8 If your initial plan doesn't work, do you have alternative plans?	Snorkle at night Surface ship as last restort Do not proceed to PD in territorial waters Continue to deeper water Transit at PD

	Sink soviet ships Return fire Continue to evade Perform stop and drop Go deep

To calculate the highest number of potential correct answers per participant, the mean of all answers was calculated A mean of 15 625 points was calculated by adding all eight potential correct answers for scenarios 1 and 2 and dividing by 16 questions The 15 625 mean was the maximum number of possible correct points given for the decision sheet questions per participant

APPENDIX J

EQUIVALENCY CALCULATIONS EXTENDED

EXPERIMENT 1

Italicized text is the original document

Below italicized text is the extended equivalency calculation(s)

Equivalency margins for performance scores were calculated by using the grading sheets as a measure of best possible performance Only questions 1 through 8 were included Question 9 was not included as a performance score because it was opinion based Because participants could choose either scenario 1 or 2, the scores for each scenario were combined *Participants were able to score a maximum of 15 625 points per question on each scenario* For scenario one, 135 points was the highest possible total score For scenario two, 115 points was the highest possible total score The sum of both high scores was 250, divided by two scenarios, left a mean of 125 points per scenario To find the average high score per question, 125 was divided by 8 for the number of decision questions This equaled 15 625 which was the highest number of possible points per participant score

The comic media and text-based media performance scores would be considered equivalent if the difference between the two conditions was less than 10 percent of the highest possible points, or 15 625 Ten percent of this value was 1 5625 The constant of 25 was added to 1 5625 and the logarithm of that number was computed so that

transformations equaled those performed on actual participant scores Ten percent of the highest possible points equaled a final value of 26

Total time to review training materials was calculated by dividing the total time allotted (30 minutes, or 1800 seconds) by 9 questions, which yielded 200 seconds per question The 200 seconds multiplied by 8 performance based questions equaled a total of 1600 seconds The comic media and text-based media speed would be considered equivalent if the difference between the two conditions was less than 10 percent of the *a priori* time (1600 seconds) Ten percent of this value was 160 Because the scores for the participants' speed were transformed by taking the logarithm of each time, the *a priori* time was also transformed The log of 160 seconds was 2 2

EXPERIMENT 2

Italicized text is the original document

Below italicized text is the extended equivalency calculation(s)

The high, medium, and low abstraction comic media performance scores would be considered equivalent if the difference between the two conditions was less than 10 percent of the highest possible points, or 15 625 Ten percent of this value was 1 5625 The constant of 625 was added to 1 5625 and the logarithm was calculated so that transformations equaled those performed on actual participant scores Ten percent of the highest possible points equaled a final value of 34 The equivalency margins for the 90% confidence intervals were calculated by taking the mean of the participants' actual performance scores (37), plus or minus the equivalency margin of 34

The high, medium, and low abstraction comic media performance scores would be considered equivalent if the difference between the two conditions was less than 5 percent of the highest possible points, or 15 625 Five percent of this value was 15 The equivalency margins for the 95% confidence intervals were calculated by calculating the mean of the participants' actual performance scores (37), plus or minus the equivalency margin of 15

The total time estimated for Experiment 2 was the same as Experiment 1 (30 minutes) The comic abstraction level speed would be considered equivalent if the difference between the two conditions was less than 10 percent of the a priori time (1600

seconds) Ten percent of this value was 160 Because the scores for the participants' speed were transformed by taking the log of each time, the *a priori* time was also transformed The log of 160 seconds was 2 2

The equivalency margins for the 90% confidence intervals were calculated by taking the mean of the participants' actual speed (2 58), plus or minus the equivalency margin of 2 2

The total view time estimated for Experiment 2 was 15 minutes The comic abstraction level speed would be considered equivalent if the difference between the two conditions was less than 10 percent of the view time (900 seconds) Ten percent of this value was 90 Because the scores for the participants' speed were transformed by taking the log of each time, the apriori time was also transformed The log of 90 seconds was 1 95

The equivalency margins for the 90% confidence intervals were calculated by taking the mean of the participants' actual view time (2 32), plus or minus the equivalency margin of 1 95

APPENDIX K

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APPENDIX L

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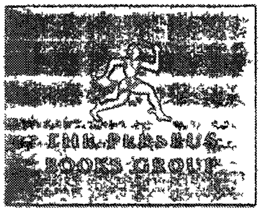

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