Investigating the Use of Color in Timeline Displays

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16. Abstract

The use of color-coding in human supervisory control displays such as those found in air traffic control is a design intervention meant to mitigate task complexity and reduce mental workload. Color has been shown to aid operators in search and organization tasks; however, it can also cause cognitive tunneling and add to task complexity. This paper details the results from an experiment designed to evaluate increasing color categories in an attempt to objectively measure how the use of color in air traffic control-related displays affects performance. Results showed that the use of six color categories, as compared to three, significantly improved subjects' accuracy in performing search and problem-solving tasks. However, beyond six color categories, performance accuracy was not significantly aided and was possibly degraded. In addition, errors of omission significantly increased when the number of color categories increased from six to nine. This study demonstrated that, especially under high workloads, color categorization beyond six groupings added to overall task complexity as a function of workload, even more than an environmental complexity factor that depends on task requirements.

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INTRODUCTION

The increasing use of color in computer displays is ubiquitous. For example, automatic teller machines, cell phones, and handheld personal assistant devices have color displays, not necessarily because they provide additional functionality, but because we *like* the variation that color provides. The recent dramatic increase of color use in air traffic control displays is also a function of consumer demand, because the use of different color categories can convey critical information needed in rapid real-time decision support. However, with advanced display technologies that allow designers to use hundreds of color conventions with no added system cost, there is little, if any, consideration of how much color might be too much from an information processing perspective.

Xing and Schroeder (2005) have documented the extensive and inconsistent color use in air traffic control (ATC) displays. Yuditsky, Sollenberger, Della Rocco, Friedman-Berg, and Manning (2002) discovered conflicting results in the use of color in radar displays and warned that more investigation was needed to determine how the use of color affected controller performance. While individual color enhancements seemed to provide benefit, when the enhancements were integrated, the beneficial effect was lost. Despite these findings, the Federal Aviation Administration (FAA) has issued no formal requirements for the use of color in ATC displays, and consequently manufacturers of ATC technologies are free to develop their own color schemes. Indeed, even ATC facilities and individual users are allowed to determine their own color preferences in some decision-support tools. While guidelines exist for the general use of color in ATC display technologies (Cardosi & Hannon, 1999; Reynolds, 1994), they generally address optimal perceptual conditions and not how the use of color will improve or degrade task performance. Because of the paucity of research on the effects of increasing color categorizations on human supervisory control performance, more specifically ATC tasks, this paper details the results from an experiment designed to evaluate different color categories. These categories were used in a timeline in an attempt to objectively measure how the use of color in air traffic control displays affects performance.

The use of color to aid in information processing dates back to early WWII aviation days in which knobs, levers, and buttons in the cockpit were often painted yellow to convey that caution should be used before activating the control (such as an emergency jettison device). Some devices were painted red to remind pilots that they should only be activated in extreme cases (such as firing a weapon or dropping a bomb.) This use of yellow and red to convey caution and warning information is still used today in modern cockpits and has become a deeply ingrained heuristic for daily life as traffic lights, signs, and labels still use this color convention.

Color in ATC displays is typically used for three primary task reasons: 1) To draw attention, 2) To identify categories of information, and 3) To organize information through color segmentation (Xing & Schroeder, 2006). Research has shown that color is superior to achromatic visual attributes (e.g., luminance, shapes, and text) in search and organization tasks primarily because color-coded information can be processed more quickly (Christ, 1975). For example, the use of red in displays to convey warning information allows operators such as pilots and ATC personnel to quickly assess a problem state.

Despite the improvements in search and organization tasks color can provide, previous research has shown that while subjects believed that color improved their ability to detect details, objectively, color did not improve target detection or identification (Jeffrey & Beck, 1972). In addition, the use of color can cause cognitive tunneling or "inattentional blindness," in which operators may miss other important information on a display because they fixate on the more salient and compelling color change (Simons, 2000). In addition, as the number of displayed colors increases, along with often dual or triple meaning to the different colors, users' perceptual and cognitive load is increased, subsequently elevating mental workload as well as increasing the likelihood of slips and errors.

Despite the increasing use of color in ATC displays, a principled objective evaluation of the impact of color usage has not been conducted. In general, subjective evaluations from air traffic controllers have rated the use of color positively in the context of reducing mental workload and job complexity (Yuditsky et al., 2002). While subjective evaluations can provide meaningful feedback, previous research indicates that although people like color usage in displays and think it improves their performance, in fact, it may not (Jeffrey & Beck, 1972). Hence, this study was intended to provide objective measures of the effect of color in displays.

METHODS

Apparatus, Participants, and Procedure

To objectively investigate the use of color in an ATC-related task, a human-in-the-loop simulation test bed was programmed in MATLAB®. Since the subject pool was primarily made up of college students, a simplified ATC task was needed that contained realistic decision support tools, yet did not require years of expertise to effectively operate. Thus, the subjects' task was that of a low-level surface manager of incoming and outgoing traffic, responsible for assisting a supervisor in ensuring that enough personnel were on hand for baggage handling, aircraft captains, and galley service.

The simulation interface shown in Figure 1 consists of a plan view (map) radar display, two timelines (arriving and departing), and a datalink interface for displaying and responding to questions. The radar screen represents the local airspace that shows incoming and outgoing traffic in a terminal control area. The circle in the middle represents the airport area in which aircraft are not displayed. The timeline contains two essential elements, much like what is used in actual ATC timelines, incoming (arriving) traffic (left) and outbound (departing) traffic (right). The incoming side of the timeline represents the time until the expected aircraft gate arrival. The outgoing side of the timeline represents the time that an aircraft begins loading passengers and baggage at the gate until it becomes airborne. Each aircraft tag contains the flight number, number of passengers, number of baggage items, assigned gate number, speed (when airborne) and altitude (when airborne). The data on the timeline and the situation display are dynamically updated every 30 sec, mimicking the information updating in ATC radar displays. The datablocks on the situation display enter to the screen from random locations and move in and out the screen at the simulated speed. In the experiment, subjects performed dual tasks: They monitored both the
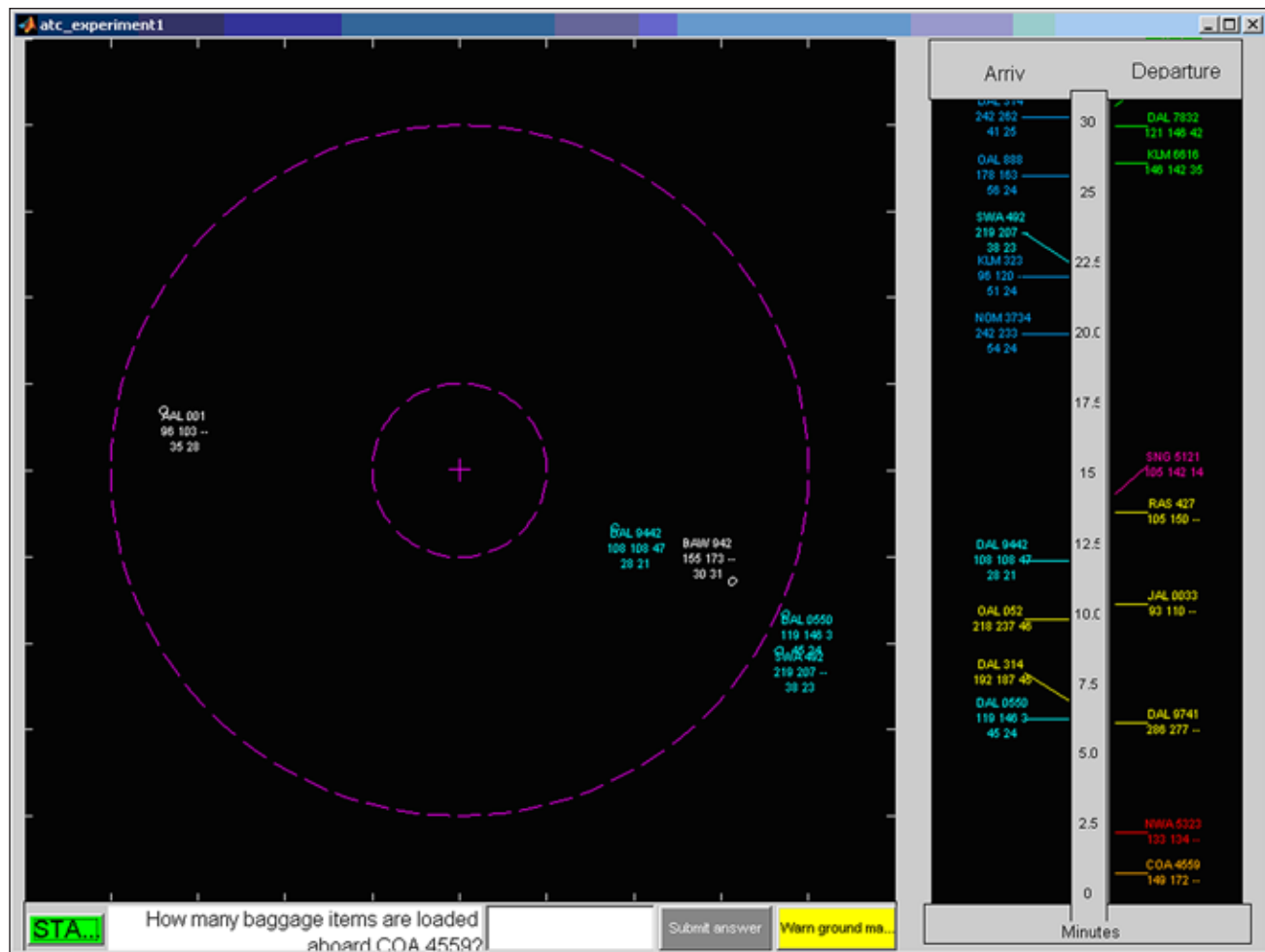

Figure 1: The simulated timeline interface. The left timeline shows the aircraft due to arrive at their gates within the next 30 minutes, and the right timeline shows those due to take off within the next 30 minutes. The radar display on the left represents the terminal control airspace around the airport, with the innermost circle representing the tower-controlled airspace. The data link interface is on the bottom of the screen and is where subjects record their answers.

radar display and timeline, and they answered questions from their superiors through datalink (text message) communication.

Training and testing were conducted using a Dell Pentium 4 computer that had a 17-inch color monitor with a screen area of 1024x768 pixels and 16-bit high color resolution. During testing, all user responses were recorded in separate files specific to each subject and scenario. A visual basic script was written to score and compile the data into a single spreadsheet file for the subsequent statistical analysis. After signing required consent forms, subjects completed a tutorial that discussed the nature of the experiment, explained the context and use of the interface, and outlined the different color categories they would experience in a graphical format. Table 1 describes the color categories in tabular format. Table 2 details the RGB vector of each of the nine colors used. Subjects completed three practice scenarios, which exposed them to all three possibilities of color category (3, 6, 9 colors). They then began the randomly assigned, 18 test scenarios that lasted approximately 3.5 minutes each.

During each scenario, subjects were required to monitor the radar display and timeline, and answer questions from their superiors through datalink (text message) communication. Two types of questions were randomly mixed in each scenario. One type was search questions (SQ), such as, "How many baggage items are aboard Delta 768?" The other type was problem-solving questions (PSQ) such as, "How many aircraft will depart in the next 20 minutes?" Appendix A lists all the questions used in the experiment. Subjects were also required to notify their superior when aircraft of a particular airline entered the middle circle of the spatial display. This technique was used to evaluate possible errors of omission related to increasing workload.

Experimental Design

The primary independent variable of interest in this experiment was the number of colors used to represent categorical information about incoming and outgoing aircraft, which, as depicted in Table 1, were three, six, and nine colors. Two secondary independent variables were investigated, number of aircraft (10, 20, 30) and arrival pattern (sequential vs. non-sequential.) Thus, the statistical model used was a 3x3x2 fully crossed ANOVA, and the 18 scenarios were randomly presented to a total of 29 subjects who are college students with normal vision.

The three levels of aircraft density were included to examine possible interaction between the number of onscreen entities (increasing workload) and the color

Table 1: Color Categories

Flight Status	Number of Colors		
	3	6	9
Scheduled to arrive	White		
En route		Blue	
En route outside airspace			Blue
En route inside airspace			Cyan
On final approach		Orange	Orange
Taxiing in	Yellow	Yellow	Yellow
On runway			Red
Ready to dock with gate			Purple
At gate	Green	Green	Green
Ready for pushback		Pink	Pink
Taxiing out	Yellow	Yellow	Yellow
In final queue (holding short)		Orange	Orange
Departed	White	White	White

Table 2: Color RGB Vectors

Color	RGB Vector
White	[1 1 1]
Yellow	[1 1 0]
Green	[0 1 0]
Blue	[0 0.5 1]
Orange	[1 0.5 0]
Pink	[1 0 0.5]
Cyan	[0 1 1]
Red	[1 0 0]
Violet	[0.7 0.5 0.9]

categories. In addition, arrival patterns could also affect a controller's ability to effectively search for information. Aircraft that maintain their relative positions in the timeline are easier to track than aircraft that appear to "jump" on the timeline, e.g., aircraft that are put into holding patterns, disrupting the expected flow of traffic. Both the increasing number of aircraft and arrival patterns represent environmental complexity while the color categories represent an intervention designed to mitigate complexity.

Multiple dependent variables were used to test the effects of both significant environmental complexities and complexity mitigation strategies. The general strategy was to measure performance using the embedded datalink tool, a strategy that has been useful in developing workload metrics in a military command and control domain (Cummings & Guerlain, 2004). The questions introduced through the datalink window fell into two categories: 1) search questions that relied on perceptual information processing, e.g., subjects had to locate a single piece of information such as the call sign of a certain aircraft, and 2) problem-solving questions, in which subjects were required to calculate or derive information from multiple sources, e.g., the number of aircraft at their gates. In each of the 18 scenarios, subjects were asked six questions, which were generally evenly split between problem-solving and search categories. The dependent variables consisted of the time subjects took to answer both question types as well as the accuracy of the answers. In addition to the requirement that subjects answer all datalink questions, they also were required to notify the supervisor when they first noted that a flight of a certain carrier entered the outermost radial circle on the spatial display. Failure to recognize this situation resulted in an error of omission, which is the final dependent variable to be measured.

RESULTS

Response Time

Response times were measured as the time between the arrival of a datalink question and entry of a response. Answers were intended to be very short, i.e., all numeric answers, so as not to confound answers with typing ability. Response times to SQ and PSQ required natural logarithm transformations to meet ANOVA normality and homogeneity of variances assumptions. For the SQ response time, the main effects of the number of aircraft and color categories were significant (both $p < .001$, $\alpha = .05$). However, because there were significant interactions for all higher order terms involving color ($p < .001$), these results can only be interpreted by examining the marginal means. Figures 2 and 3 show plots of marginal means for time versus color category for the different numbers of aircraft. Figure 2 illustrates results for search questions and Figure 3 for problem-solving questions.

Figure 2 indicates that as the number of aircraft increased, response times increased for search questions, which is expected since there were more entities to search on the radar display and the timeline. The interaction was significant, and there is no clear pattern that can be discerned for color. For 10 aircraft, increasing color usage tended to improve search time; however, for 20 and 30 aircraft, increasing color usage did not appear to either help or hurt response time.
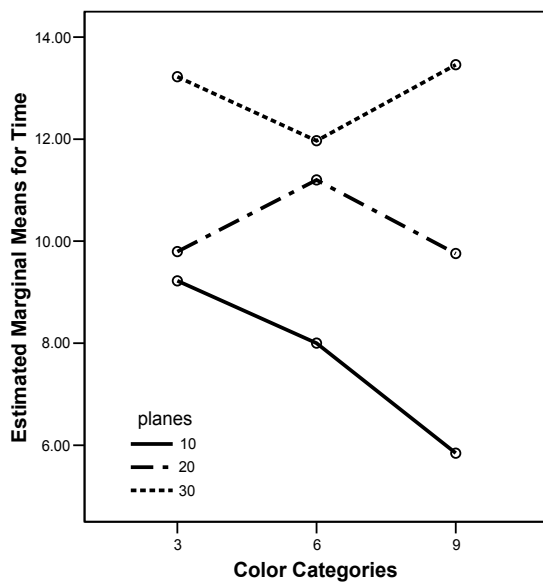

Figure 2: Search Question Response Time: Color vs. Aircraft Number
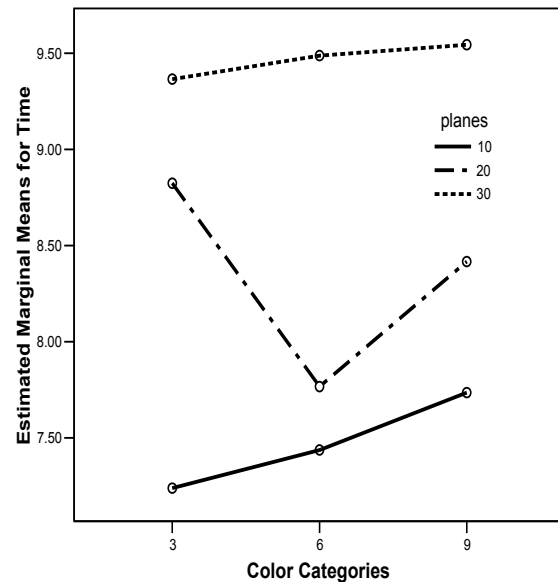

Figure 3: Problem-Solving Response Time: Aircraft vs. Color

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For the PSQ response time, color was not significant but arrival pattern and the number of aircraft were (p = .027 and p < .001, respectively). There were no significant interactions. Figure 3 demonstrates that increasing the number of aircraft caused longer problem-solving time, regardless of color usage. While there appears to be a large dip for 20 aircraft and 6 color categories, the difference was only one 1 sec. It is likely an indication that the questions generated under this category were easier to answer than the others. In future studies, greater effort is needed to ensure parity of questions. Figure 4 shows the plot of marginal means for response time versus arrival pattern for the different aircraft numbers. This graph demonstrates that non-sequential arrival patterns caused higher response times than sequential patterns. That is expected since controllers must rearrange their mental models for the traffic picture when aircraft do not arrive in a sequential fashion and, thus, take longer when calculating relevant information.
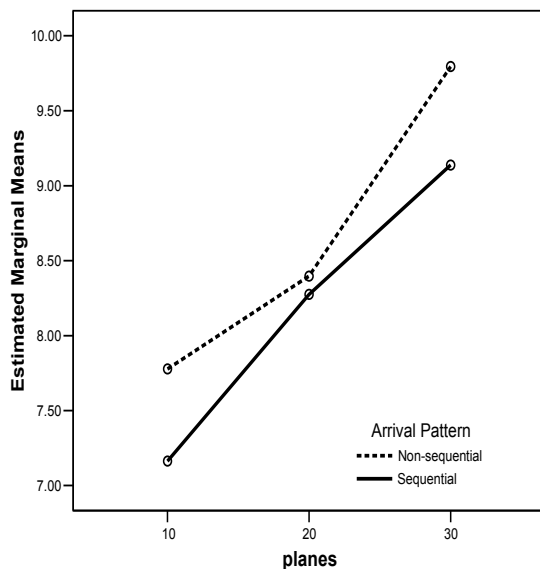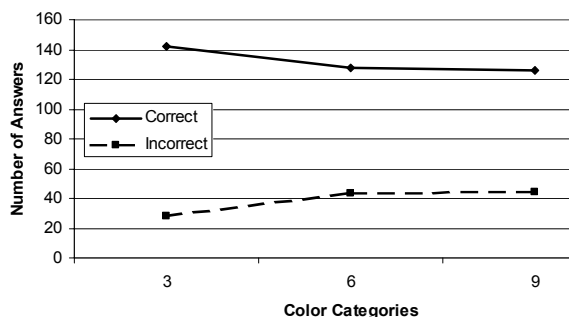
Performance Accuracy

While response times can provide important performance metric information, it is equally important, if not more so, to consider how a particular experimental condition affected answer accuracy. For this experiment, subjects were classified as "accurate" if they achieved greater than 2/3 accuracy for test questions in a particular scenario. An overall comparison of subject performance accuracy for the search and problem-solving questions in each of the 18 test sessions reveals intriguing results. Figure 5 shows plots of the number of correct and incorrect answers versus color category for search questions. For the search questions, additional color categories increased inaccuracy, most predominantly from three to six color categories, however, the general subject population had a relatively high level of accuracy (Pearson Chi-Square showed marginal significance, p = .069).

Figure 6 shows the relationship between the number of correct and incorrect answers versus color category for problem-solving questions. For the problem-solving questions, the increase in color categories actually improved answer accuracy, although there was no difference between the uses of six or nine color categories (Pearson Chi-Square test showed p < .001). Generally, for both question types, wrong answers typically increased with the number of aircraft. Measures of association using Cramer's V are reflected in Table 3. For the search questions, arrival patterns and number of aircraft, both environmental complexity factors, affected correct answers while increasing aircraft and color categories were both moderately associated with wrong answers.

Omission Errors

The incorrect answers given by the subjects to datalink queries represent errors of commission. We also examined the influence of the color categories on omission error occurrences, as well as increasing environmental complexity due to increasing numbers of aircraft and non-sequential arrival patterns. Subjects were told that whenever an arriving aircraft marked as BAW (British Airways) entered
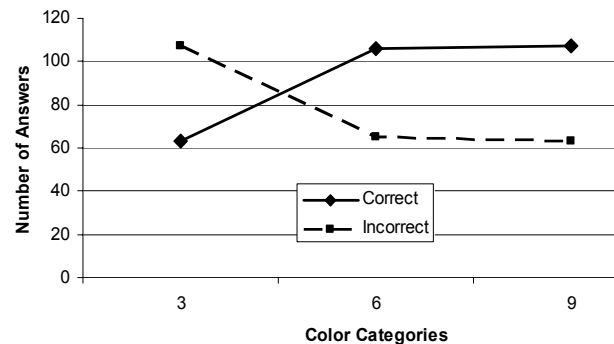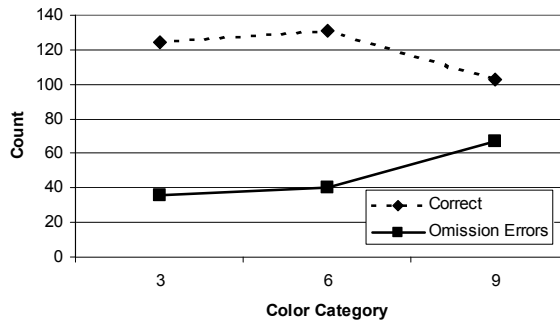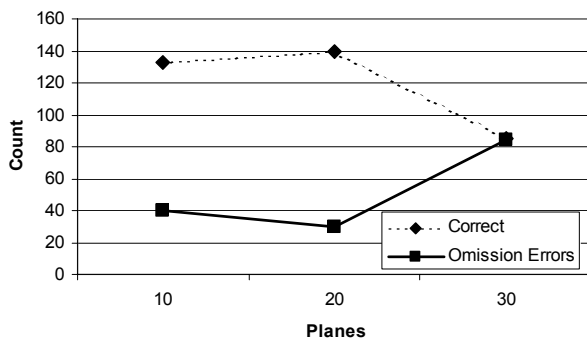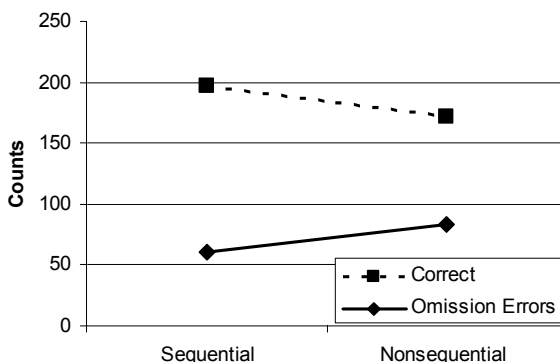

Figure 4: Problem-Solving Response Time: Arrival Pattern vs. Aircraft

Figure 5: Accuracy for Search Questions

Figure 6: Accuracy for Problem-solving

Table 3: Accuracy Measure of Association

	Search Accuracy	Problem-Solving Accuracy
Color Categories	.102 (p=.069)	.240 (p < .001)
Aircraft Density	.269 (p < .001)	.275 (p < .001)
Arrival Pattern	.327 (p < .001)	Not significant

the area between the two dashed circles on the radar display in Figure 1, they were to notify their supervisors by clicking the "Warn Ground Manager" button on the lower right part of the screen. A Wilcoxon Signed Rank Test showed that the difference between the two samples (correct notifications and errors of omission) was significant (p = .009), and for all independent variables, correct answers exceeded errors of omission.

Figure 7 represents the number of overall correct notifications as compared to the errors of omission for the color categories. A Mann-Whitney test between the number of errors for the six and nine color categories was significant (p = .001). Figure 8 demonstrates a similar trend of omission error increasing between 20 and 30 aircraft (Mann-Whitney, p < .001). The arrival pattern effect is seen in Figure 9. Subjects' errors of omission increased when the arrival patterns were non-sequential, and the difference between sequential and non-sequential patterns was significant (Mann Whitney, p = .036).

Given that all three independent variables showed significance through non-parametric testing, further investigation was warranted to determine the magnitude of the significant relationships. Association testing using the Kendall tau-b statistic revealed significant associations for all three variables, as shown in Table 4. As color categories increased from 3 to 9, and as aircraft increased from 10 to 30, errors of omission increased, as indicated by the positive association. Subjects that experienced sequential arrival patterns made less omission errors, as indicated by the negative association. All associations were moderate, but the factor of the number of aircraft, an environmental complexity factor, contributed only slightly more to error rates than the number of colors, a factor designed to mitigate complexity.

Figure 7: Omission Errors: Color Categories

Figure 8: Omission Errors: Number of Aircraft

Figure 9: Omission Errors: Arrival Pattern

Table 4: Measures of Omission Error Association

Factor	Association	Significance
Color Category	.330	p < .001
No. of Aircraft	.355	p < .001
Arrival Pattern	-.293	p = .001

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One problem with the previous non-parametric analyses was the lack of consideration of interaction effects. Since the numbers of aircraft and color categories contributed almost equally to error rates, a graph of the color categories for each aircraft level was generated to further investigate the nature of any interaction. Figure 10 represents the number of omission errors for each color category (3, 6, 9), as well as the number of aircraft (10, 20, 30). The largest increase in omission errors occurred for those subjects with 30 aircraft and 9 color categories.
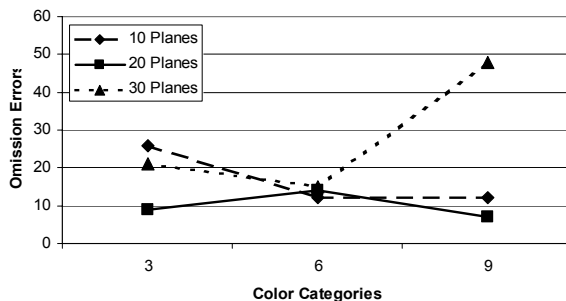

Figure 10: Color vs. Number of Aircraft

DISCUSSION

This experiment investigated how performance, as measured by response time, accuracy, and omission errors on a simulated ATC-like task was affected by varying color categories, the number of aircraft, and arrival patterns. Several important trends were noted.

Number of Aircraft

The number of aircraft was included because it represents a primary source of environmental complexity for controllers. Expectedly, as the number of aircraft increased, the response time for both search and problem-solving questions increased. In addition, the performance accuracy declined, and errors of omission increased as the number of aircraft increased. Increasing numbers of entities for consideration is a known significant component of information complexity (Edmonds, 1999) and is cited as a major source of air traffic control complexity (see Majumdar & Ochieng, 2002, for a review). This experiment provides quantitative evidence for this theory.

Arrival Pattern

Traffic flow is another commonly cited source of ATC complexity (Majumdar & Ochieng, 2002). This environmental complexity factor was represented in this study by arrival patterns that were sequential as opposed to non-sequential. It was hypothesized that arrival pattern would be a less significant factor across dependent variables, which was the case. Arrival pattern was not

significant for search times but was significant for problem-solving times. This result is not surprising because if a person expects to find information about an aircraft in one area but its original sequence is disrupted, a new search is initiated, taking more time. Arrival pattern was moderately associated with the accuracy to search questions, indicating that perhaps subjects did not recognize a positional change on the timeline that led to incorrect answers. Finally, arrival pattern significantly affected subjects' errors of omission, however, to a less degree than both the number of aircraft and color categories. Arrival patterns did not directly cause errors of omission, but non-sequential patterns increased search time, and thus increased overall workload, which diverted attention from the monitoring task. We need to point out that the simulated arrival patterns are over-simplified compared with those in real ATC operations. Thus, it is possible that the relatively moderate association between the arrival patterns and performance is because we did not capture the complicated nature of the arrival patterns in real ATC operations.

Color Categories

The number of color categories was the primary independent variable in this study. While the number of aircraft and arrival patterns are factors of environmental complexity and, thus, cannot be controlled in advance, color categories can be controlled because color-coding is a design intervention meant to mitigate complexity and aid users in expeditious and safe handling of aircraft. Across several different dependent variables, this experiment suggests that using more color categories (e.g., from three to six) provides no additional benefit in performance; moreover, using a large number of color categories (more than six) can actually degrade performance.

The results of response times to datalink questions were mixed. For search questions, increasing the number of color categories reduced response times for ten aircraft but provided no benefit for higher aircraft densities. For problem-solving questions, increasing color categories provided no statistical improvement in response times. For the answer accuracy measure, color-coding significantly improved the rate of correct answers from the three to six color category but reached a plateau at six, so nine color categories provided no additional benefit.

The analysis of errors of omission in the context of color categories provides evidence that using more than six color categories can introduce performance problems. When nine color categories were represented, errors of omission increased significantly from the three and six color categories that produced essentially the same error rates. While the number of aircraft exhibited a slightly stronger association for errors of omission, color categories

were a significant contributor to errors of omission, more so than the arrival rate of aircraft. While increasing color categories does not "cause" people to forget actions, it does require subjects to spend more time in search and mapping tasks, so it may take away time from other tasks and increase the likelihood that a subsequent or concurrent task will be forgotten. This is an important finding because color-coding is a design intervention meant to mitigate complexity, not add to it. In this study, the use of color-coding beyond six categories, especially for high workload situations, caused degraded performance through increased errors of omission.

CONCLUSION

The use of color-coding in human supervisory control displays is a design intervention meant to mitigate task complexity and reduce mental workload. Color has been shown to aid operators in search and organization tasks. In this study, the use of a few color categories significantly improved subjects' performances in answering search and problem-solving questions during a monitoring task more accurately than the use of three color categories. However, this experiment suggests that beyond six color categories, performance accuracy is not aided and is possibly degraded. In addition, errors of omission significantly increased from six to nine color categories, so increasing color usage might prompt attentional blindness or cognitive tunneling.

Investigation of other environmental sources of complexity revealed that increasing the number of aircraft affected subjects' performances slightly more than increasing color categories; however, varying traffic arrival patterns was not as strongly associated with degraded performance as the other two factors. This finding is important because the use of color in displays is meant to reduce task complexity, not add to it. This study demonstrated that, especially under high workloads, color categorization beyond six groupings resulted in more errors of omission, even more than an environmental complexity factor that cannot be controlled. These results are in line with previous recommendations (Cardosi & Hannon, 1999) that no more than six colors should be used in an ATC display. However, further research is needed to examine the effects of multiple meanings for color categorizations and the role of context for these categorizations.

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Search questions and problem-solving questions used in the experiment.

Scenario Coding

111 – 10 aircraft, 3 colors, sequential
112 – 10 aircraft, 3 colors, non-sequential
121 – 10 aircraft, 6 colors, sequential
122 – 10 aircraft, 6 colors, non-sequential
131 – 10 aircraft, 9 colors, sequential
112 – 10 aircraft, 9 colors, non-sequential

211 – 20 aircraft, 3 colors, sequential
212 – 20 aircraft, 3 colors, non-sequential
221 – 20 aircraft, 6 colors, sequential
222 – 20 aircraft, 6 colors, non-sequential
231 – 20 aircraft, 9 colors, sequential
212 – 20 aircraft, 9 colors, non-sequential

311 – 30 aircraft, 3 colors, sequential
312 – 30 aircraft, 3 colors, non-sequential
321 – 30 aircraft, 6 colors, sequential
322 – 30 aircraft, 6 colors, non-sequential
331 – 30 aircraft, 9 colors, sequential
312 – 30 aircraft, 9 colors, non-sequential

Question Type

SQ – Search Question: *Answers to these question types required the search for a single specific piece of information on the display.*

PSQ – Problem-solving Question: *This question type required the aggregation of multiple pieces of information into a single result via a count.*

	Type	Question
111	PS	How many aircraft departing in the next 30 minutes are at their gates?
111	PSQ	How many aircraft currently in the air are arriving in the next 20 minutes?
111	SQ	In how many minutes will AFR 3203 be arriving?
111	SQ	How many passengers aboard DAL 145?
111	PSQ	How many flights departing in the next 20 minutes?
111	SQ	At what gate is JAL 0091?
112	PSQ	How many aircraft are arriving in the next 15 minutes?
112	PSQ	How many arriving aircraft are currently taxiing?
112	PSQ	How many aircraft still at their gates are departing in the next 20 minutes?
112	SQ	In how many minutes will SWA 315 be arriving?
112	PSQ	How many flights currently in the air are arriving in the next 25 minutes?
112	SQ	At what gate is UAL 518?
121	PSQ	How many departing aircraft are ready for pushback?
121	PSQ	How many aircraft at their gates are departing in the next 25 minutes?
121	PSQ	How many arriving aircraft are on final approach?
121	SQ	How many passengers aboard AAL 1478?

(Continued)

121	SQ	At what gate is COA 791?
121	PSQ	How many flights currently in the air (and not on final approach) are arriving in the next 20 minutes?
122	PSQ	How many arriving aircraft are on final approach?
122	PSQ	How many aircraft at their gates are departing in the next 30 minutes?
122	PSQ	How many aircraft departing in the next 20 minutes are ready for pushback?
122	SQ	How many baggage items aboard AAL 214?
122	PSQ	How many flights currently in the air (and not on final approach) are arriving in the next 30 minutes?
122	SQ	At what gate is AAL 518?
131	PSQ	How many arriving aircraft are ready to dock with the gate?
131	PSQ	How many arriving aircraft are currently inside the airspace?
131	SQ	In how many minutes will COA 2020 be arriving?
131	SQ	How many bags loaded aboard UAL 335?
131	PSQ	How many arriving aircraft are taxiing in?
131	PSQ	How many departing flights are holding short of a runway?
132	PSQ	How many aircraft, departing in the next 30 minutes, are currently at their gates but not yet ready for pushback?
132	PSQ	How many aircraft departing in the next 20 minutes are ready for pushback?
132	SQ	How many passengers incoming aboard DAL 325?
132	SQ	In how many minutes will LMD 0121 be departing?
132	PSQ	How many taxiing aircraft will be arriving at their gates within the next 15 minutes?
132	PSQ	How many arriving flights are on final approach?
211	PSQ	How many arriving aircraft are currently taxiing?
211	PSQ	How many aircraft are arriving in the next 20 minutes?
211	PSQ	How many aircraft at their gates are departing in the next 30 minutes?
211	SQ	In how many minutes will JBU 312 be arriving?
211	SQ	At what gate is LAN 4971?
211	PSQ	How many flights currently in the air are arriving in the next 20 minutes?
212	PSQ	How many aircraft are arriving in the next 10 minutes?
212	PSQ	How many aircraft departing in the next 30 minutes are currently taxiing?
212	SQ	In how many minutes will TRS 222 be departing?
212	PSQ	How many aircraft currently at their gates will be departing in the next 20 minutes?
212	PSQ	How many flights currently in the air are arriving in the next 15 minutes?
212	SQ	At what gate is AFR 3213?
221	PSQ	How many departing aircraft are holding short of their runways?
221	PSQ	How many departing aircraft are ready for pushback?
221	PSQ	How many aircraft arriving in the next 20 minutes are taxiing?
221	SQ	How many baggage items arriving aboard UAL 323?
221	PSQ	How many flights currently in the air (and not on final approach) are arriving in the next 30 minutes?
221	SQ	To what gate is BAW 733 assigned?
222	PSQ	How many departing aircraft are ready for pushback?
222	SQ	To what gate is AAA 199 assigned?

(Continued)

222	PSQ	How many aircraft arriving in the next 25 minutes are still in the air (and not on final approach)?
222	PSQ	How many aircraft arriving in the next 10 minutes are currently taxiing?
222	SQ	How many baggage items arriving aboard BAW 3514?
222	PSQ	How many flights leaving in the next 25 minutes are still at their gates and not ready for pushback?
231	PSQ	How many departing aircraft are on runways?
231	PSQ	How many aircraft arriving in the next 15 minutes are currently taxiing?
231	PSQ	How many aircraft arriving in the next 20 minutes are on final approach?
231	SQ	At what gate is BAW 942?
231	SQ	How many passengers are arriving aboard NWA 333?
231	PSQ	How many arriving flights are ready to dock with their gate?
232	SQ	At what gate is SNG 5121?
232	PSQ	How many aircraft departing in the next 30 minutes are ready for pushback?
232	SQ	How many baggage items are loaded aboard DAL 2294?
232	PSQ	How many aircraft arriving in the next 30 minutes are still outside the airspace?
232	PSQ	How many aircraft are on final approach?
232	PSQ	How many flights arriving in the next 10 minutes are taxiing in?
311	PSQ	How many aircraft departing in the next 25 minutes are at their gates?
311	PSQ	How many aircraft arriving in the next 5 minutes are currently taxiing?
311	PSQ	How many aircraft currently in the air will be arriving in the next 20 minutes?
311	SQ	In how many minutes will NWA 1116 be arriving?
311	SQ	How many baggage items are arriving aboard BAW 7132?
311	SQ	At what gate is ASA 963?
312	SQ	At what gate is DAL 313?
312	SQ	In how many minutes will SWA 041 be departing?
312	PSQ	How many aircraft currently in the air will be arriving in the next 15 minutes?
312	PSQ	How many aircraft arriving in the next 10 minutes are currently taxiing?
312	SQ	How many baggage items are arriving aboard AFR 9191?
312	PSQ	How many aircraft departing in the next 25 minutes are at their gates?
321	PSQ	How many arriving aircraft are on final approach?
321	PSQ	How many aircraft at their gates are departing in the next 25 minutes?
321	SQ	How many baggage items arriving aboard DAL 393?
321	SQ	In how many minutes will HAL 421 be departing?
321	PSQ	How many flights currently in the air (and not on final approach) are arriving in the next 25 minutes?
321	SQ	At what gate is DAL 1993?
322	SQ	How many baggage items arriving aboard WAW 332?
322	PSQ	How many aircraft arriving in the next 30 minutes are on final approach?
322	SQ	In how many minutes will NER 042 be arriving?
322	PSQ	How many arriving aircraft that are currently taxiing, will be arriving in the next 15 minutes?
322	SQ	At what gate is ARL 238?
322	PSQ	How many flights currently in the air (and not on final approach) are arriving in the next 30 minutes?

(Continued)

331	PSQ	How many departing aircraft are ready for pushback?
331	SQ	How many bags loaded aboard HAL 103?
331	PSQ	How many aircraft arriving in the next 30 minutes are currently on a runway?
331	PSQ	How many arriving aircraft are currently inside the airspace but not on final approach?
331	PSQ	How many departing flights are holding short of a runway?
331	PSQ	How many aircraft departing in the next 30 minutes are still at their gates but not yet ready for pushback?
332	PSQ	How many arriving aircraft are currently inside the airspace but not yet on final approach?
332	PSQ	How many departing aircraft are ready for pushback?
332	PSQ	How many aircraft arriving in the next 15 minutes are currently taxiing?
332	SQ	How many bags are arriving aboard DAL 1223?
332	PSQ	How many aircraft departing in the next 25 minutes are still at their gates and not yet ready for pushback?
332	PSQ	How many departing flights are holding short of a runway?