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Task Difficulties, Eye Conditions and Visual Acuity Tasks Among Selected Students of The University of Lagos, Nigeria

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Abstract

The study was designed to experimentally investigate task difficulties, eye conditions and visual acuity search tasks. The task used was the searching for a specific number or members within an array of members. 60 volunteered undergraduates of University of Lagos from across 6 faculties of the University, Akoka campus were the participants. A repeated measure 3x3 factorial design was used. There were 9 conditions of task difficulties x eye conditions, each consuming 3 minutes, making a total of 27 minutes. Four hypotheses, one of which stated that in visual acuity search tasks, there would be "eye-effect," were tested. 3 of the hypotheses were strongly supported while 1 was rejected. Hypothesis 1 with ($D=160.68 > N=140.72$, $p<0.5$) was significantly supported. Based on the status of the hypotheses, recommendations were made, one of which was that those who engage in any visual acuity search task that requires monocular viewing should always identify and use their dominant eye for effective performance.

Keywords: Task Difficulties, Eye Conditions, Visual Acuity, Attention.

1. Introduction

Every human task, no matter how minute, has some measure of factors that aid its effective performance. Whenever people's performances are classified as high and low, what this implies is that the variation in performance (high and low) is caused by certain factors which are either absent or present in the task situation (Baddeley& Weiskrantz,1993; Baker, 2005; Coole, 2003; Poncheri, 2006). In such task situations, the influences of the factors are usually dichotomous. Sometimes their presence facilitates performance and in other situations they hinder performance.

These task influencing factors could be organismic in nature, organismic factors are factors present in people which are either inherited or acquired from the environment. Such factors are uniquely present in people to the extent that they can influence performance in assigned tasks. Some examples of such factors are; intelligence, personality, physique, finger dexterity, emotions experience, perceived inequity and eye-conditions (Fagbohungbe, 2000; Akinmayowa, 1975, McLeod, 2008).).

On the other hand, the factors could be loaded in the task itself, for example, task difficulty or the complexity of tasks, and time required for effective performance of the task (Davis, Lesley & Shackleton, 1973). In other situations task influencing factors could be located in the environment (internal and external) in which the task is to be performed. Internal environmental influencing factors could include the policy of an organisation, equipment, welfare packages, and career prospect. External environmental factors include government policies, infrastructures climatic conditions and competitors (Fagbohungbe, 2009; Eze, 2004).

The present study is designed to carry out further empirical study on task performance influencing factors with the focus on two category factors which are task inherent factors known and referred to as task difficulties and organismic factors herein referred to as eye-conditions. In more specific terms, the study was designed to investigate the influence of task difficulties and eye-conditions on the visual acuity of students.

2. Problem definition

Educationists have found out that students' performance in examinations is aided by a group of factors such as intelligence, attention, teaching facilities, method of teaching and the quality of the teachers. In like-manners, some tasks can only be effectively performed if the performer has high visual acuity e.g. driving a vehicle, flying a plane, reading a radar, dept-study, reading books and searching for items, just o mention a few. Therefore, the goal of this study was to investigate how task difficulty and eye-conditions would influence the sampled students' performance in visual acuity search task.

3. Literature Review

Literature is replete with studies which are related to task difficulties and eye-conditions. However, a number of studies have direct relevance to the understanding of task difficulties and eye conditions. Among such notable studies is Broadbent (1958) experiment popularly known as (dichotic listening). Donald Broadbent is recognised as one of the major contributors to the information processing approach, which started with his work with air traffic controllers during the war. In that situation it was recorded that a number of competing messages from departing aircraft are arriving continuously, all requiring attention. The traffic controller finds that he can deal

effectively with only one message at a time and so has to decide which the most important (McLeod, 2008) is. From this circumstance, Broadbent designed an experiment (dichotic listening) to investigate the processes involved in switching attention which are presumed to be going on internally in our brains. In the process of trying to understand how people are able to focus attention (selective attend), people are deliberately overloaded with stimuli –i.e. they had too many signals, too many information to process at the same time.

Participants were exposed simultaneously to two messages, one message (a 3-digit number) to a person's right ear and a different message (a different 3-digit number) to their left ear. They were asked to listen to both messages at the same time and repeat what they heard. This is known as a "dichotic listening task". Result from this research led Broadbent to produce his 'filter' model of selective attention. Filter model of "selective attention" requires that stimuli are filtered so that attention is directed. It further suggests that the selection of materials to attend to (that is, the filtering) is made early, before semantic analysis (McLeod, 2008). Teisman's (1964) attenuation model retains this earlier position of Broadbent's 'filter' model, which works on physical features of the message only, but it eliminated the unattended materials.

In the light of these previous studies, Davies, Lesley and Shackleton (1973) investigated the effect of music and task difficulty on performance at a visual vigilant task. The participants were 40 undergraduates (20 male and 20 female) between the ages of 18 and 28 years who were paid for their services. There were 4 conditions of the experiment, Noise Easy (NE), Noise Difficulty (ND), Music Easy (ME) and Music Difficulty (MD). Ten participants (5 males, 5 females) were assigned to each of the experimental conditions. Participants were tested individually and in isolation their task was to detect and respond to changes in the brightness of light situated at eye-height at a view distance of 1.38m. Response taken were correct detection, commission errors, detection latencies and'd' values.

Result showed that for the difficult version of the task, a significant increase was found which music prevented. Broadly similar finding were obtained for correct detections. The similarity between Davies et al (1973)'s study and the present study is in the area of variable manipulation. The both manipulated the independent variable 'task difficulty;' the only variation being in the number of manipulations. While Davies et al (1973) had two; the present study has three which are 1-item, 2-items and 3-items.

Munucci and Conners (1964) in his study manipulated eye-condition, left-eye, right-eye and binocular (both eyes) to measure how they affected reaction time. What he did was to present visual stimulus separately to the right eye, left eye and to binocular (both eyes). The reaction times were taken at 4 different intensity levels of the reaction time stimulus from lowest to highest. The result showed that reaction time deceased as the stimulus intensity increased. The reaction time were also shorter the order of binocular, dominant eye and non-dominant eye. Munucci and Conners (1964) is similar to the present in the manipulation of variables, but while the present study manipulated number of items, Munucci and Conners (1964) manipulated the intensity levels of the reaction time.

Matlin (1995) came up with the signal detection theory which came up other factors that can influence visual acuity and these are expectation and motivation. It states that a sensation or stimulus for which people have high expectation and motivation will be detected quicker and faster. According to D. E. Broadbent's (1958) as sited by Lachter, Forster, and Ruthruff (2004) selective filter theory, people do not process unattended stimuli beyond the analysis of basic physical properties. This theory was later rejected on the basis of numerous findings that people identify irrelevant (and supposedly unattended) stimuli. A careful review of this evidence, however, reveals

strong reasons to doubt that these irrelevant stimuli were in fact unattended. Lachter, Forster, and Ruthruff (2004) in a similar study revealed that this review exposed a clear need for new experiments with tight control over the locus of attention. The authors present 5 such experiments using a priming paradigm. When steps were taken to ensure that irrelevant stimuli were not attended, these stimuli produced no priming effects. Hence, the authors found no evidence that unattended stimuli can be identified. The results support a modern version of Broadbent's selective theory, updated to reflect recent research advances.

Handa (2004) quantitatively studied eye dominance using balanced technique based on binocular rivalry which moderates the relationship between sighting and sensory dominance. Shneora and Hochstein (2007) in a study found better performance for detecting an odd element with dominant eye than with the non-dominant eye. In the same vein Encyclopedia Britanical (2009) supports the present study by the submission that visual acuity is typically measured monocularly and not binocularly. This informed the use of 3 eye conditions (dominant eye, non-dominant eye and binocular) in the present study.

4. Operational Definition f Terms

All the variables of interest in the study are defined in the context of the study:

- **Visual Acuity Search Task** is the use of multiple stimuli with participants' task being that of location a particular item or series of items as specified by the experimenter. The number of item or items located constitutes a participant's performance.

- **Task Difficulty** refers to the complexity of the visual acuity search items. Search for an item e.g. 67 is a simple task, search for two items simultaneously e.g. 46 and 28 is more difficult and search for three items simultaneously e.g. 93, 31 and 73 is most difficult.

- **Eye conditions** refer to dominant eye, non-dominant eye and binocular (both eyes combined).

- **Eye Dominance** refers to the functional superiority of one eye (left or right) over the other. A dominant eye is expected to search more items than the non-dominant one.

- **Performance** refers to the number of items correctly located and cancelled by each participant.

- **Binocular Search** refers to searching with both eyes at the same time.

5. Hypotheses

The study was guided by 4 hypotheses that adequately captured the essence of the study.

1. In a visual acuity search task there will be "Eye-Effect" with the dominant eye searching more items than the non-dominant eye.
2. In a visual acuity search task there will be "Difficulty Effect" with performance decreasing as difficulty level increases.
3. There will be "Interactional Effect" between Eye Condition and Task Difficulty in visual acuity search task, that is, eye condition multiplied by task difficulty (EC x TD) will produce significant effect on searched items.
4. There will be "Summation Effect" in visual acuity search task, that is, the Binocular will search more items than each of the dominant and non-dominant eye.

6. Research Method

6.1 Study Location

The study was carried out at the University of Lagos, Akoka campus. It covered Faculties which are Arts, Business Administration, Education, Engineering, Law and Sciences. Faculty of Social Sciences students were deliberately excluded due to their familiarity with social science research method.

6.2 Participants/Sample

The participants were 60 volunteer students with 10 from each of the 6 Faculties listed above. Participants' age ranged from 19-29 years with mean= 22.30, SD= 9.33. None of them used eye glasses and none had been treated for serious eye ailments in the past.

6.3 Design

The design adopted in this study was a repeated measure factorial design (a 3x3 repeated measure factorial design).

Eye Conditions

Task Difficulty	N	D	B
1-item			
2-items			
3-items			

A 3x3 Repeated Measure Factorial Design

Eye conditions (non-dominant eye, dominant eye and binocular) were crossed with Task difficulty (1-item, 2-items and 3-items). Eye conditions x Task difficulties were the independent variables manipulated while scores in the task constituted the dependent variable.

6.4 Instrument

Pieces of block cloth made into adjustable "eye pads" that can be switched from left to right eye and vice versa.

- Stop watch
- Task booklets containing the search items. The task used in this study was extracted from the book titled "A Laboratory Manual Psychology by Chris Spatz, pages 97-109.
- Instruction sheets
- Pencils for crossing located visual acuity searched items

6.5 Procedure

A pilot study using 5 participants was first carried out and this assisted the experimenter to measure the feasibility of the study as necessary adjustments were made before the real study.

The main study was broken into two parts A and B. Part A was to measure participants' visual acuity search task performance. Part B was for the identification of participants' dominant eye.

Part A: The instruction papers were first given to the participants to study for 2 minutes. Thereafter, the experimenter read and explained the instructions. This was followed with a demonstration of what to do by participants. The experimenter and his 2 assistants who happened to be psychology students who were already familiar with varied experimenter study did the demonstration.

Part of the instruction information read thus:

"The first page top portion of the booklet before you contains questions about yourself and you are required to supply the information. The purpose of this is to enable the experimenter give you a feedback on the outcome of the study.

You will be performing an exercise called visual acuity search tasks with one or the other of your eyes covered and at a stage with your both eyes not covered. Your eye cover is the "eye pad" before you. Now watch me as I demonstrate.

Be very honest to provide effective eye cover in order that you may be able to generate useful data for the purpose of this study. Now get set to start while you allow the experimenters to guide you under strict time limit, as you move from one segment of your booklet to the other"

There were a total of 9 conditions of eye condition and task difficulty with each one consuming 3 minutes. Therefore, the first part of the experiment took 27 minutes altogether.

Part B: Part B was the determination of the dominant eye through the technique described below:

1. i. Hold your right first finger about 30.48cm (1 foot) away from your nose
   ii. Focus on that marked point in your front. It is about 91.44cm (3 feet) away from you.
   iii. Cover your left eye with your Eye pad (cover it very effectively so that you cannot see anything with it).
   iv. Continue to focus on the point 3 feet (91.44cm) away.
   v. Report the behaviour of your finger in the space below:

   _____

   _____

   _____

2. The same process was repeated for the second eye but this time around it was the right eye that was covered while the participants viewed with the left.

The presumption here and which had been tested by Ufot (1979) was that a finger viewed with the dominant eye from this specified distance will appear stable while it will appear unstable if viewed with the non-dominant eye.

In each of the faculty, more than 10 volunteered students were allowed to participate but only the first 10 that reported finger stability under any of the eye (left or right) were used for the final analysis.

6.6 Data Collection

After the experiment, the scores for each participant, as per task page, were recorded by counting the number of items correctly crossed. So the total scores were recorded at the bottom left of each task page.

For hypotheses one and two, Duncans Multiple Range Test were used. Hypothesis 3 was tested with a treatment by treatment by participant analysis while in addition Duncans Multiple Range Test was used to locate the source interaction between the 9 means A-I. For the last hypothesis 4, Duncans Multiple Range Test was used to measure task difficulty means.

7. Results

The first challenge was to know the true status of hypothesis 1 which states that there would be "eye effect" in visual acuity search task with the dominant eye searching more items. Table 1 below showed the analysis.

Table I: Duncans Multiple Range Test Applied to the Difference between Means for Eye-Conditions

EYE CONDITION	MEANS	N 140.72	D 160.78	B 166.62	rp	RP
1 Non-dominant	140.72	-	19.96	25.9	r^2= 2.77	R^2= 9.24
2 Dominant	160.68	-	-	5.94	r^3= 2.92	R^2= 9.47
3 Binocular	166.62	-	-			

Where N = Non-dominant eye, D= Dominant eye; B= Binocular

N D ⟷ B

In Table I, the fact that N and D are not linked showed them to be significantly different. D has a higher mean (*X*) = 160.68 while N has a lower mean (*X*) = 140.72. This showed that the dominant eye searched more items, thereby supporting hypothesis 1 that there will be "eye-effect" with the dominant eye searching more items.

The second challenge was to confirm the status of hypothesis 2 that in visual acuity search task, there would be "difficulty effect" with performance decreasing as level of difficulty increased. Table II below showed the analysis.

Table II: Duncans Multiple Range Test Applied to the Difference between Means for Task Difficulty

TASK DDIFFICULTIES	MEANS	3-Items 110.30	2-Items 153.26	1-Item 203.60	rp	RP
C Lowest	110.30	-	42.96	93.30	r^2= 2.77	R^2= 11.30
B Next	153.26	-	-	50.34	r^3= 2.92	R^2= 11.90
A Largest	203.60	-	-			

Where A= 1-Item difficulty; B= 2-Items difficulty; C= 3-Items difficulty

C, B, A

As could be viewed in Table II above, none of the means C, B, A were linked and this showed that they were significantly different from one another. 1-item difficulty had the largest mean (*X*)= 203.60, 2-items difficulty with mean (*X*)= 153.26 while 3-items difficulty had the lowest mean (*X*)= 110.30. This result supported hypothesis 2 that performance would decrease as level of difficulty increased.

The third hypothesis stated that eye-conditions would interact with task difficulties to produce significant effect on visual acuity searched items. The analysis for this was displayed below.

Table III: Summary of Results

Eye-Conditions by Task Difficulties by Participants

Source	SS	df	MS	F	RP
Total	149277.80	539			
Subject	51136.50	59			
Eye Condition (EC)	8969.50	2	4484.73	221.26*	.05
Task Difficulty (TD)	79416.60	2	38708.30	175.48*	.05
EC x TD	2073	4	518.25	5.898*	.05
Error EC	2390.80	118	20.26		
Error TD	26029.70	118	220.59		
Error ECxTD	20738.30	236	87.87		

P<.05*; Where EC= Eye Condition, TD = Task Difficulty.

Table III above showed that there was a joint contribution of the independent variables (eye conditions and task difficulty) with F-ratio value F(4, 118)=5. 898, p<.05. This result indicated that the two independent variables (eye conditions x task difficulties) interacted significantly to contribute to the performance of the participants in terms of number of items searched in the visual acuity search task.

In order to locate the source of significance and therefore interaction among all the 9 means (*X*) A-I, Duncan's Multiple Range Test was employed. Table IV below showed the analysis.

Table VI: Duncans Multiple Range Test Applied to test the significance of all the 9 Means (*X*) in order to locate the Source of Interaction

MEANS	F	G	H	I		
	BCDE	G-(AB CDEF)	H-(A BCDEFG)	I-(ABC DEFGH)	rp values	Rp values

A lowest	56.40	58.62	69.33	72.60	r^2= 2.77	Rp^2= 9.24
B	21.90	24.12	34.83	38.10	r^3= 2.92	Rp^3= 9.24
C	18.78	21.00	31.71	34.25	r^4= 3.02	Rp^4= 9.24
D	17.05	19.27	29.98	33.25	r^5= 3.09	Rp^5= 9.24
E	11.32	13.54	24.25	27.52	r^6= 3.15	Rp^6= 9.24
F	4.43	6.65	17.36	20.63	r^7= 3.19	Rp^7= 9.24
G		2.22	12.93	16.20	r^8= 3.23	Rp^8= 9.24
H			10.71	13.98	r^9= 3.92	Rp^9= 9.24
I Largest				3.27		

A to I represent the Mean (X) for the 9 cells

A ⟷ B ⟷ C D E ⟷ F G H ⟷ I

From the above analysis the unlinked Means (X) were significantly different from each other, while the linked ones were not. Note should be taken of the insignificant differences between 2-items difficulty and 3-items difficulty respectively. This implied that when 2-items difficulty was searched, the scores decreased and decreased the more when it was 3-items difficulty. This happened with the 3 eye conditions (non dominant/ dominant/binocular). The implication of this was that the influence of eye condition (irrespective of type) was conditioned by the difficulty level of the task. The sources of interaction were mostly between eye condition and 3-items difficulty level on the other hand. Therefore this implied that influence on performance in visual acuity search task came from 2 and 3 items difficulty levels that interacted with eye conditions.

To test the last hypothesis 4, Duncan Multiple Range Test was also used. Table 1 showed the analysis. The hypothesis stated that there would be "summation effect" with the Binocular searching significantly larger items than both the dominant and non dominant eyes. Looking at the Mean (X) scores for the 3 eye conditions, B=166.62, D=160.78 and N= 140. Whereas a link between two variables in accordance with Duncans Multiple Range Test implied such variables are not significantly different from each.

Therefore, looking at Table II, the results showed N ⟷ D ⟷ B meaning non dominance and dominance are significantly different whereas binocular and dominance are not significantly different from each other because they are linked. Based on this result hypothesis 4 that expected a summation effect was therefore rejected.

8. Discussion

The present study exami9ned the relationship between task difficulties, eye condition and performance in visual acuity search task. 4 hypotheses were tested and results provide significant support for 3 of the hypotheses while the 4th one was rejected.

The first hypothesis tested for "eye effect" in visual acuity search task comparing performance of non-dominant eye with the dominant eye. Result showed that the dominant eye searched significantly more items than the non-dominant eye. This result aligned with earlier findings such as Davies et al (1973), Robboy et al (1990), and Handa (2004).

Similarly hypothesis 2 that measured difficulty effect was also significantly supported. This is also confirmed in literature (Munucci et al, 1964; Matlin, 1995; Ooi et al, 2001; Blake & Logothetis, 2002).

Hypothesis 3 which had the challenge of testing whether the two independent variables (task difficulties and eye conditions) would interact to produce significant effect on the number of items searched was also strongly supported. This position was expressed in Encyclopadia Britanical (2009). Shneora and Hochstein (2007) finding also supported it. Gazzaniga et al (2002) and Lumer (1998), all support the position of hypothesis 3.

Hypothesis 4 on "summation effect" that the binocular would search the largest number of items, followed by the dominant eye and the non-dominant eye searching the list was rejected. The number of items searched by the binocular was not significantly different from that of the dominant eye. This of course is a unique finding because it brought the power of the dominant eye at influencing visual acuity search task. This further highlight the need for people to identify and use their dominant eye in any visual acuity related task that demands monocular (the use of one eye).

However, the rejection of the hypothesis perhaps, has socio-cultural connotation. In African culture and in deed Nigeria, physiology is not allowed to determine, for example, the appropriate hand (left or right) to use. It is rather socially determined. Therefore it is not a matter of what one prefers but rather what is socially and culturally approved. This probably account for why in many ethnic groupings in Nigeria, the use of the right hand is favoured over the left, even though it may be non-dominant. It is also believed among some Yoruba that the constant use of one preferred eye may make such eye become squinted. These reasons might have led to the rejection of the "summation effect" hypothesis. Otherwise, if physiology had been the sole determinant, then the binocular should have searched the largest number of items.

9. Conclusion and Recommendations

There is no doubt that the present study demonstrated the effects of task difficulties and eye conditions on visual acuity search tasks. The eyes searched items significantly in order of dominant to non-dominant eye. This showed the superiority of the dominant eye over the non-dominant eye. The study also demonstrated in clear terms that as difficulty level increased, the number of items successfully searched in the visual acuity search tasks decreased.

Based on the conclusion drawn above, it is hereby recommended that: Individual should endeavour to identify which of their eye (left or right) is dominant through the simple exercise used in the present study. In all activity or task situations that have to do with visual acuity and monocular viewing such as using equipment like microscope, radar cameras and aiming with guns, they should view with the dominant eye.

It is used for diagnostic purpose in the case of eye defect. In such a situation the dominant eye will require less powerful lens so as to balance the victims' vision. Therefore knowing the dominant eye can facilitate effective diagnosis.

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