Poster Presented at the April (2007) 35th Annual Western
Pennsylvania Undergraduate Psychology Conference. Grove City, PA.

Human Ramonsneds[1]

Leah M. Fitzgerald
Robert Morris University

While it is clear that humans are capable of recognizing randomness in their environments, it is not clear whether humans are capable of intentional randomness. The present study examined this issue by having participants push random buttons on a 7x7 button-grid (150 trials). Results were that participants could not respond randomly. The accumulation of button presses produced by human participants differed significantly from computer simulated ("chance") responses. Participants favored and avoided specific locations on the response grid relative to simulated participants.

Introduction

Wasserman, Young, and Cook (2004) argued that a preference for, and therefore the ability to recognize randomness in the environment is an adaptive quality among humans and other animals. Essentially, the argument is that stability in the environment requires different responses compared with unstable or changing environments. Survival often depends on an ability to discriminate between these two environmental conditions. While it seems clear that humans are capable of recognizing randomness in their environments, it is not clear whether humans are capable of generating randomness (or making random selections) intentionally (cf. Nickerson, 2004; 2005).

In a subjective random generation (SRG) task, individuals are asked to generate strings of random numbers (Wagenaar, 1972). The findings are that people participants usually do not behave randomly. That is, they tend to produce far fewer number repititions than chance would predict (Budescu, 1987). Typically, failures in random number generation have been attributed to expectations and beliefs (e.g., the Gambler's Fallacy), and subjective perceptions of randomness (Brugger, 1997; Brugger, Landis, & Regard, 1990).

A participant's expectation can greatly interfere with any experiment. Even with the best possible directions for a task, individual beliefs about the meaning of those directions can alter results. Nickerson (2004) made the point that unless a participant completely understands the nature of the task they are being asked to perform, their performance cannot be adequately assessed. In other words, although research tends to portray humans as incapable of generating random responses, unless it can be demonstrated that participants understand the nature of randomness, such portrayals may be inaccurate. Demonstrating that research participants understand the concept may not be possible unless researchers themselves can first come to such an agreement.

Although "randomness" is often defined internally by experimenters, valid results based on that definition are still not possible because of participants' varied definitions and understandings of the concept (Nickerson, 2004). In other words, Nickerson argues that results obtained from participants cannot rule out the possibility that their performance was reasonable according to their own interpretations of random production.

It is significant that researchers have demonstrated that reinforcement or feedback plays a role in SRG (Neuringer, 2004). Reflexes are involuntary actions produced by humans, whereas voluntary actions are choice responses often occurring in a predictable manner. Reasons for predictable patterns of responding include reinforcement, or, operant conditioning. That is,

[1] Address correspondence to: Stephen T. Paul, Ph.D., 6001 University Blvd., Moon Township, PA 15108-1189, or via email at: paul@rmu.edu.

the consequences derived for behaving in a particular manner influence how we will respond in a similar situation in the future. Therefore, randomness, like any other behavior, may be susceptible to the same learning principles.

If behaving randomly must be a consciously thought out process, as has been argued by Blackmore, Galaud and Walker (1994), then it becomes unclear as to what is meant by "true randomness". Consider that random number generation has been shown to require conscious attention (Gottselig et. al., 2006). Gottselig and colleagues found that executive functioning of the prefrontal cortex compromised as a result of sleep deprivation. The task that demonstrated impairment required participants to maintain random responding. As sleep deprivation increased, responses became less random (more repetitive).

Neuringer (2004) also supports the idea of attention as a consideration when discussing human random production. He makes a strong case that although people may generally fail in meeting the requirements of randomness, there is an additional reduction in performance as attention is divided. Therefore, attending to the activity seems to lead to increases in random outputs.

A majority of the literature examining random behavior among humans has relied on two linear methods: (1) Generating random coin tosses (e.g., Ayton & Fischer, 2004), or (2) Generating random numbers (e.g., Neuringer, 2004). To the extent that random behavior requires conscious effort (cf. Neuringer, 2004) then these types of responses produce a heavy memory load on participants who must monitor the patterns of their responses over time. Indeed, humans are particularly bad at this sort of task as evidenced by the finding that chimps outperform humans in memory span tasks (Kawai & Matsuzawa, 2000). It is also the case that this type of responding is not representative of the types of visual random patterns experienced in our natural environments. Consequently, the failure to effectively demonstrate whether humans can produce random patterns of behavior may be related to the linear response methods typically used.

The present study will examine the possibility of randomness among humans by having participants attempt to create multiple random visual patterns. It is expected that, to the extent that visually random patterns are less representative of the typical linear responses examined, participants' responses should more closely reflect random responding. On the other hand, if it is the case that multiple spontaneous responses from humans follow the underlying biases inherent in subjective views of "randomness", non-random patterns should emerge.

Method

Participants

Subjects were 12 college-aged, predominantly white undergraduates (6 women and 6 men) from a small private university in western Pennsylvania. Participants were volunteers sampled from general psychology classes who were given extra course credit as an incentive to take part in the research.

Design

This experiment utilized a 2 (Participant) x 4 (Grid Location) mixed subjects design in which Participant (human versus computer) was manipulated between subjects and Grid Location (center, corners, middle-+, middle-x) was manipulated within subjects. The dependent variable was the proportion of presses that the response buttons received within each of the grid locations.

Materials

A program was written to display a 7x7 array of computerized buttons (grey with a light blue background) on a color computer monitor. All buttons were initially blank except for the starting button (middle of the grid) which contained a large "O" in its center. As each button was pressed (beginning with the starting button), it turned green and a number from 1 to 15 appeared in its center which indicated the order of the presses. Pressing a numbered button more than one time had no effect. The trial ended when the fifteenth button was pressed. At which point a message appeared that informed participants to "click to continue" to the next trial. Once all trials were completed, the program exited.

Procedure

After providing their consent to participate, volunteers were seated in front of a computer monitor and mouse. On the screen appeared the following information for them to read at their own pace:

When you press the START button, a screen containing 49 buttons will appear (one button will have a circle inside it). Your task will be to click on 15 random buttons as quickly as possible.

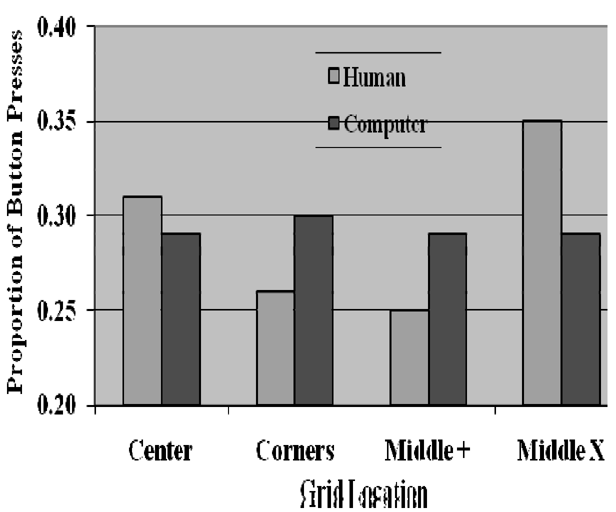
1. *Your FIRST button to click will be the one containing a circle. From then on, please select new buttons at random.*
2. *Keep clicking on a new random button until no more buttons can be clicked.*
3. *If you have any questions, ask them now, otherwise, wait until the experimenter tells you to begin. When told to begin, you may click on the START button below and begin selecting your random buttons.*

Results

A 2 (participant type) x 4 (grid location) mixed analysis of variance was performed on participants' average button presses over 150 trials. The results of this analysis revealed a significant main effect of Grid Location, $F(3, 60) = 3.50$, $p < .05$. More importantly, the analysis revealed an interaction between Participant Type and Grid Location, $F(3, 60) = 3.79$, $p < .05$.

The interaction (depicted in Figure 1) shows that human responses across the different grid locations were very different from the relatively uniform outcomes produced by computer-generated responses across the same grid locations.

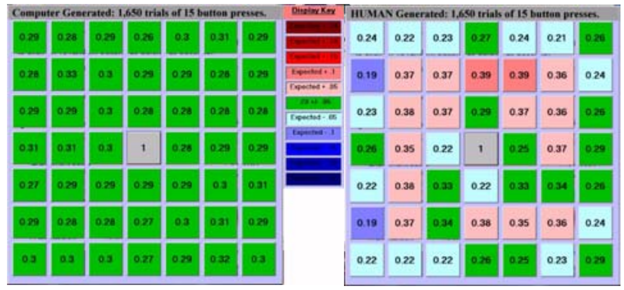
Figure 1: Grid by Participant interaction.



Conclusions

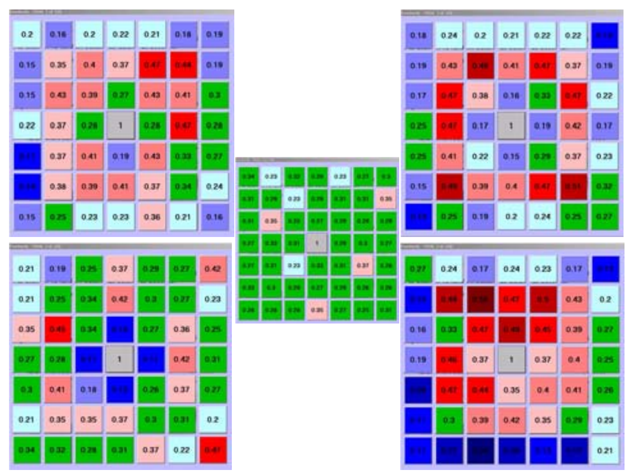
Clearly, human performers were unable to provide an accumulation of responses that approached what would have been expected by chance (see Figure 2).

Figure 2: All computer vs. all human responses.



Instead, participants appear to favor and avoid certain locations on the grid as can be seen in Figure 3.

Figure 3: All computer vs. all human responses.



Two interesting directions of research present themselves based on the current data. First, and related to the findings of Neuringer (2004), because participants did not receive feedback concerning their progress, it remains to be seen whether they would continue to show biased response patterns over time if they were reinforced to avoid systematic responses. Neuringer claims that, although people tend to emit predictable response patterns, when varied responding is reinforced, can approximate the random model. A further look into reinforcing effects on biased response patterns would be a logical step from here.

Second, the underlying nature of the response biases among the human participants requires closer examination. For example, a preference emerged that participants tended to avoid pressing the buttons adjacent to the starting location, and, that participants tended to prefer pressing buttons closest to the outer-most boundaries of the grid. By relocating the start point, it would be interesting to see whether these response biases persisted.

References

Ayton, P., & Fischer, I. (2004). The hot hand fallacy and the gambler's fallacy: Two faces of subjective randomness? *Memory & Cognition, 32*(8), 1369-1378.

Blackmore, S. J., Galaud, K., & Walker, C. (1994). Psychic experiences as illusions of causality. In Cook, E. and Delanoy, D. (eds). *Research in Parapsychology 1991*. Metuchen, N.J., Scarecrow, 89-93.

Brugger, P. (1997). Variables that influence the generation of random sequences: An update. *Perceptual and Motor Skills, 84*, 627-661.

Brugger, P., Landis, T. & Regard, M. (1990). A "sheep-goat effect" in repetition avoidance: Extra-sensory perception as an effect of subjective probability? *British Journal of Psychology, 81*, 455-468.

Budescu, D. V. (1987). A Markov model for generation of random binary sequences. *Journal of Experimental Psychology: Human Perception and Performance, 13*, 25-39.

Gottselig, J. M., Adam, M., Rétey, J. V., Khatami, R., Achermann, P., & Landolt, H. (2006). Random number generation during sleep deprivation: Effects of caffeine on response maintenance and stereotypy. *Journal of Sleep Research, 15*, 31-40.

Heuer, H., Kohlisch, O., & Klein, W. (2005). The effects of total sleep deprivation on the generation of random sequences of key-presses, numbers and nouns. *The Quarterly Journal of Experimental Psychology, 58A*(2), 275-307.

Kawai, N, & Matsuzawa, T. (2000). Numerical memory span in a chimpanzee. *Nature, 403*, 39-40.

Neuringer, A. (2004). Reinforced variability in animals and people. *American Psychologist, 59*(9), 891-906.

Nickerson, R. S. (2004). The production and perception of randomness. *Psychological Review, 109*(2), 330-357.

Nickerson, R. S. (2005). Bertrand's chord, Buffon's needle, and the concept of randomness. *Thinking and Reasoning, 11*(1), 67-96.

Wagenaar, W. A. (1972). Generation of random sequences by human subjects: A critical survey of the literature. *Psychological Bulletin, 77*, 65-72.

Wasserman, E. A., Young, M. E., & Cook, R. G. (2004). Variability discrimination in humans and animals: Implications for adaptive action. *American Psychologist, 59*(9), 879-890.

Wegner, D. M., Fuller, V. A., & Sparrow, B. (2003). Clever hands: Uncontrolled intelligence in facilitated communication. *Journal of Personality and Social Psychology, 85*(1), 5-19.