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BRIEF REPORT

PERCEPTUAL OUTCOMES AS REINFORCERS

Catherine Sumpter and James McEwan

UNIVERSITY OF WAIKATO, NEW ZEALAND

The paucity of basic behavioral research with humans was highlighted almost 40 years ago (Findley, 1966). A recent search of the basic behavioral research journals by the present authors indicated that this situation remains, with only approximately 15% of the research using human participants. It may seem surprising that so few studies use human participants given the apparent practical advantages of doing so. Human participants are readily available, extensively pre-trained, can use a range of complex apparatus and require no feeding or housing. In reality, however, the use of human participants involves a number of practical difficulties: humans generally will not agree to participate in research involving a large number of sessions or sessions lasting more than two to three hours; it is difficult to gain within-session compliance as a result of the often repetitive and simplistic nature of the tasks; and it is often unclear whether the experimental results are a product of the experimentally-arranged contingencies or the instructions given to the participants. Another difficulty, that which is addressed here, lies in the identification of a suitable experimental outcome that will serve as a reinforcer.

Outcomes typically selected for use in animal research, such as food and water, function as reinforcers because the organism has been deprived of those nutritive outcomes. Clearly, any such deprivation is ethically unacceptable when working with humans. Although researchers working with humans have used food outcomes, it is unclear if they function as a reinforcer in laboratory situations given the absence of food deprivation. A related problem is that satiation will diminish the reinforcing effectiveness of the nutritive outcome.

To attempt to overcome the problems associated with nutritive outcomes, researchers often use points exchangeable for access to toys, videos and other items. However, this approach can be expensive, and the effectiveness of the points relies on the establishment of a clear relationship between the points and the post-experimental consequence.

An alternative to using points and nutritive outcomes is to arrange perceptual outcomes, such as the presentation or termination of an auditory or visual stimulus. Such stimuli can be delivered immediately after a behavioral requirement has been met rather than after the experimental session, and are relatively inexpensive. The reinforcing efficacy of perceptual outcomes has also been demonstrated, both in animal and human research. Schwartzbaum (1964), for example, has shown that monkeys will reliably respond in order to gain access to a period of visual exploration. Presentations of brief TV or video segments or brief access to a computer game have also reinforced human behavior (e.g., Hackenberg & Pietras, 2000; Navarick, 1996, 1998). However, the same authors have also shown that longer segments of video or TV footage are preferred to shorter segments and, on the basis of their results, argued that the reinforcing effectiveness of such stimuli depend on whether or not, and to what extent, the stimuli are segmented (i.e., discontinuous). This obvious need for continuity of presentation conflicts with the need in human experimental research to provide multiple, but periodic, presentations of reinforcing stimuli that are both immediate and brief.

Extending earlier work using computer games in human operant research (e.g., Case, 1995; Case, Ploog & Fantino 1990) we have developed a computer-based task, referred to as "Jigsaw", which also uses perceptual outcomes, but avoids the disadvantage of TV/video segments or computer game access. In the jigsaw task, the perceptual outcomes are independent of each other and do not have to happen in a particular sequence or in rapid succession to be an effective reinforcer. The computer jigsaw task is analogous to working on a conventional jigsaw puzzle where

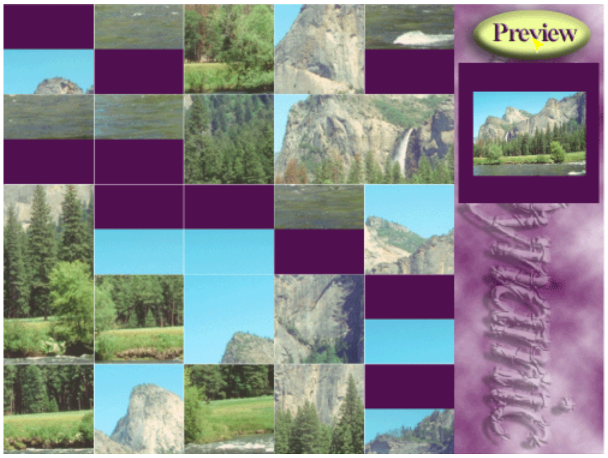

Figure 1

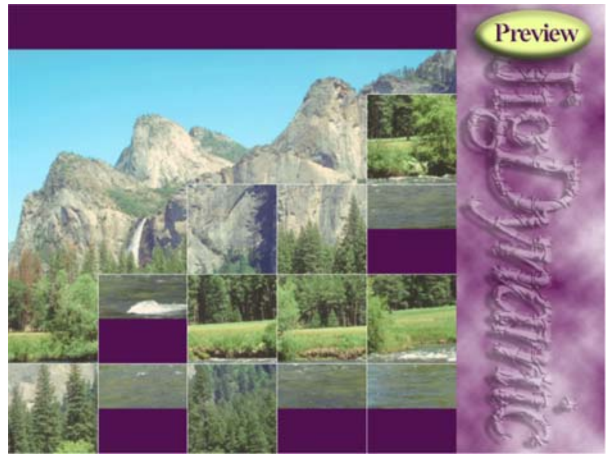

Figure 2

there is no predetermined order or rate in which the pieces need to be shifted, rotated or flipped.

The basic jigsaw task requires the participant to reveal the image on each piece of the jigsaw and/or to rearrange the pieces to complete the picture. The jigsaw program is implemented on a PC under Windows using Direct-X and C++. Figure 1 shows an example of the jigsaw program presented at the start of an experimental session. In this example, the jigsaw consists of 25 pieces laid out in a five-by-five pattern on the left-hand side of the screen. To the right of the jigsaw is a preview button which, when the curser is placed on top of it, displays a small illustration of the completed jigsaw directly beneath it. Figure 2 illustrates a partially completed jigsaw where some of the pieces are correctly joined to an adjacent piece as indicated by the absence of a white line between them. The preview window is not visible in this figure as the cursor is not over the preview button.

Within the basic jigsaw framework the tasks required to complete the jigsaw can be varied in a number of ways. The number of jigsaw pieces can differ, they may need to be revealed by altering their opacity or they may need to be rotated to the correct orientation. Completion of any of the set tasks can be achieved using a range of input devises (e.g., mouse, eye-tracker, joy-stick, graphics tablet) and can be made dependent on a number of different behavioral requirements. For example, successfully relocating a revealed jigsaw piece may require that the piece be moved across the screen at a particular speed using a joy stick, or perhaps revealing a piece may require the depression of a graphic tablet pen within a particular force range, or a rotation of a piece may depend on a particular number of mouse clicks. These behavioral requirements can also be combined. For example, a piece may be revealed by a number of pen depressions of a certain duration and within a certain force range.

In our laboratory, the utility of the jigsaw for use in behavioral research has been established with a range of procedures. In all cases, participants have been highly compliant with the task requirements, ethical concerns such as deception and deprivation have been avoided, and the arranged perceptual outcomes have produced clear and rapid control over the participants' behavior. To date we have used the procedure to look at schedule performance, within session effects and shaping procedures.

Figure 3 presents a brief example of data collected using the jigsaw procedure, examining the effects of increasing FR requirements on jigsaw performance, this is a behavioral-economic method often used to assess reinforcer strength. In this procedure, participants (undergraduate students) could not rearrange the pieces of the puzzle until a red opaque layer, see Figure 4, was removed from all of the jigsaw pieces. Each of the first five pieces, selected with the mouse, required two mouse clicks to remove the layer, the next five pieces required four mouse clicks, the next, eight clicks etc, until the last five pieces, which required 512 clicks each. The data presented here are from one 50-min experimental session and show the results from four participants, with the mean and standard deviation of the inter-response times

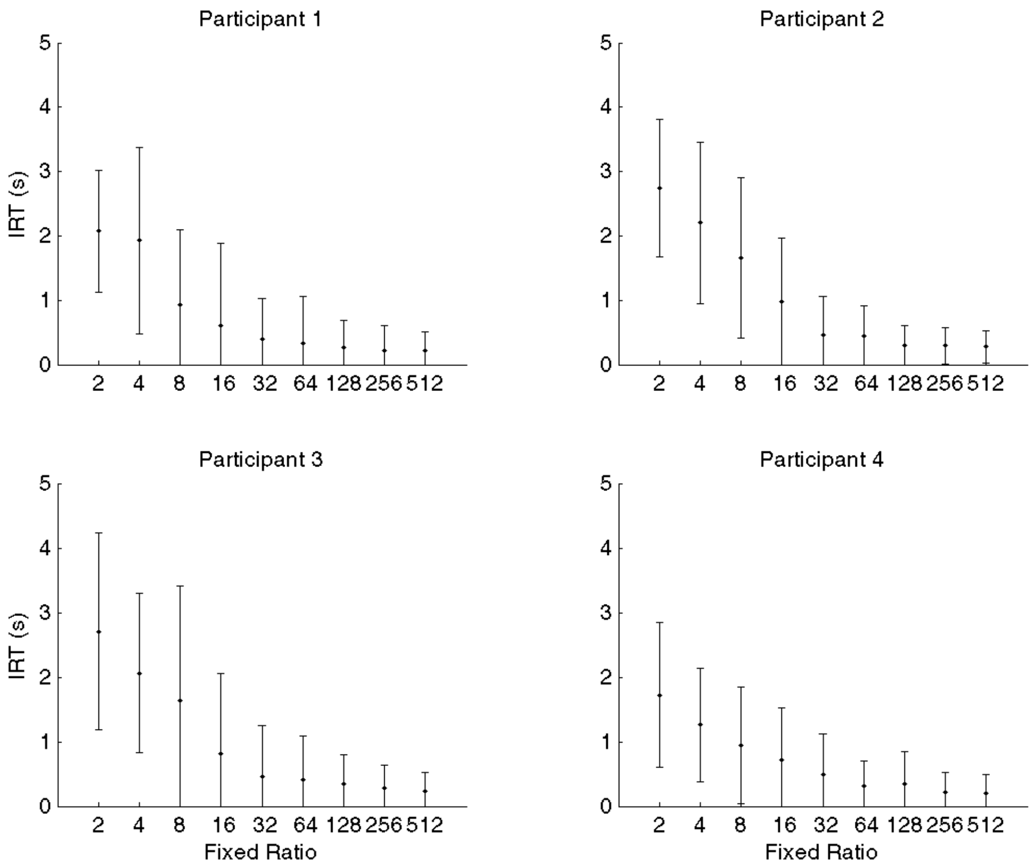

Figure 3

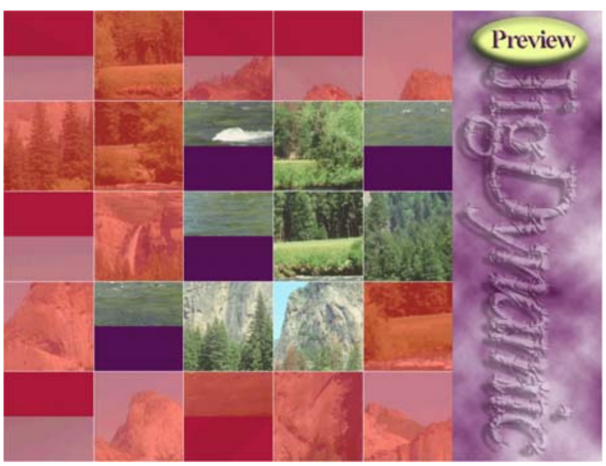

Figure 4

(IRTs) plotted for each of the FR requirements. From Figure 3 it can been seen that the participants continued to respond at the largest arranged FR value (FR 512), even though they could terminate a session at any time. In addition, the participants' IRTs decreased, and therefore their response rates increased, as the FR requirements were increased from FR 2 to FR 512. The data in this figure also provides little indication of satiation effects, as each participant completed the experimental task which required 5110 responses (i.e., moving five jigsaw pieces and therefore completing each FR requirement five times).

Since in the Jigsaw both the typical response requirements and the perceptual outcomes are immediate and brief (i.e., unlike 3-s access to grain) a large range and number of behavioral events can be arranged and recorded in a relatively short period of time (i.e., typically one 60-min session). Because the task is computer controlled, it also allows the manipulation of a broad range of behavioral requirements, including: force, number, location, duration and complex combinations of these, as well as enabling us to use any of a vast range of possible perceptual consequences as reinforcers. However, the most significant outcome of this project is not the jigsaw program itself, but the recognition that rapid and brief perceptual outcomes, of the kind that can be arranged by computers, can serve as reinforcers for adult humans, whilst avoiding most of the problems associated with other kinds of arranged outcomes used with adult humans. It is hoped that in the future the use of perceptual outcomes as reinforcers will open the way to increasing the use of humans in basic behavioral research.

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