MANIPULATING THE SALIENCE OF STIMULUS & RESPONSE FEATURES IN THE SPATIAL PRECUING TASK

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in
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By

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Abstract

Reeve, Proctor, Weeks and Dornier (1992) demonstrated that the Gestalt grouping principles could be used to influence performance in the four-choice spatial-precuing task by enhancing the organizational features of the stimulus and response sets. Reeve et al. (1992), concluded that the most effective manipulations may be limited to those involving the stimulus set. The two present experiments attempted to enhance the organizational features of the stimulus-response (S-R) sets by increasing the response ensemble's salience through the use of textures placed according to the Gestalt principles as used by Reeve et al. (1992). Both experiments confirmed the previous findings of Reeve et al., reaffirming that the relative salience of stimulus set features is a powerful determinant of the coding operations that occur during the translation stage of information processing. Furthermore, the results indicated that, although perhaps not as powerful, manipulation of response set organization through the use of textures can produce results consistent with those obtained with the stimulus set manipulations.

Acknowledgements

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Review of Literature

Since the introduction of the information-processing model of human performance, a considerable amount of research has been conducted to further investigate the proposed stages that comprise the model (Sternberg, 1969; Sanders, 1980; Proctor, Reeve & Weeks, 1990). The main research focus has been to reveal more accurately the cognitive operations that occur as an individual actively engages in the processing of information.

The origins of the contemporary model can be traced back more than a century to the work of a Dutch physician, F.C. Donders (1868/1988). From these roots, contemporary scientists have expanded on the main themes of the original model and subsequently specified three basic components or stages (Schmidt, 1988; see Figure 1).

The Three Stage Model of Information Processing

As illustrated in Figure 1, the presentation of a meaningful stimulus in the immediate environment requires an individual to first detect the presence of a stimulus prior to actively engaging in the cognitive processing of the information conveyed in the stimulus presentation. This process of "perception" takes place in the first stage of the proposed model deemed the Stimulus Identification Stage (Schmidt, 1988).

Following the initial process of perception, one is required to transform this information into a product which is "internally recognizable" and "neurologically communicative" (Teichner & Krebs, 1974). Therefore, it is suggested that the perceived environmental

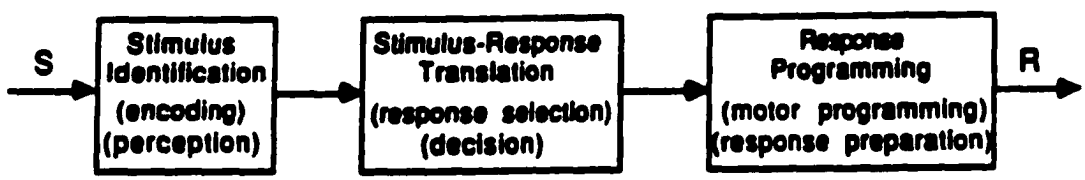


Figure 1. - The Three Stage Model Of Information Processing.

information is classified and subsequently converted into useable mental codes that allow accurate transmission into the next phase of processing, the Stimulus-Response Translation Stage (Proctor & Reeve, 1990).

Once the pertinent coded information enters the translation stage, a decision must be generated regarding the usefulness of the perceived information, and more specifically, how it should be acted upon. If the information is deemed relevant to one's current circumstance, and a decision is made to follow-up on the information perceived, it must be determined which of the vast array of possible responses would be most appropriate for satisfying the requirements of the current condition (Schmidt, 1988). The selection process now being complete, the individual continues by formulating a precise and exacting neuro-motor plan for the execution of their response. Once this "plan of action" has been compiled, and the execution of the selected response has taken place, the whole process can begin again with the added benefits of the updated information (Proctor & Reeve, 1990). These output processes have been proposed to occur in the last stage of the proposed model known as the Response Programming Stage. It is thought that these same three processes (stimulus identification, stimulus-response translation and response programming) occur across all sensory capacities regardless of its origin or input modality. Therefore, any form of stimuli taken in from the environment be it visual, auditory, olfactory or tactile is seen as a source of information and consequently, cognitively processed in

the same manner.

Although all three stages contribute to the effective completion of the information processing cycle, it is a widely held view that the translation stage is crucial for the efficient and accurate selection of any ensuing response (Proctor & Reeve, 1990).

The Translation Stage

The translation stage is considered the point in the three stage model at which the external environmental stimulus interacts with, and ultimately influences, response execution (Proctor et al., 1990). Consistent with the computer based analogy adopted by the information processing model, one could refer to the translation stage as the point at which an "interface" occurs between stimulus information and response programming. This suggests that the assignment of stimuli to responses may ultimately influence the final response output. The premise being that the translation stage involves mediating processes that work off mental codes that represent both the stimulus input and the response output.

One important and robust phenomena generally considered to be a result of translation processes, is that responses tend to be executed more efficiently and accurately when the initial stimulus presentation has a direct spatial or conceptual link to the required response (Proctor, Reeve & Van Zandt, 1992). Moreover, when this type of scenario occurs, it is inferred that the extent of internal processing required for response execution is minimized (Proctor & Reeve, 1990). The term compatibility, as first proposed

by A.M. Small, has dominated the current literature in an attempt to describe the observed facilitating effect of direct stimulus to response mapping (Fitts & Seeger, 1953; Reeve & Proctor, 1990). The term compatibility, may be formally defined as "a state in which a collection of variables harmoniously exist together without mutual contradiction" (Lexicon, 1989).

One method utilized by contemporary researchers for determining the degree of compatibility between a stimulus and it's required response is through the measurement of reaction time (RT). Specifically, increases or decreases in RT are considered highly representative of the relative efficiency of the internal processes associated with the translation stage (Reeve & Proctor, 1990; Reeve et al. 1992). A prototypical study that demonstrates the compatibility phenomena uses a simple two-choice reaction task in which subjects use their left and right index fingers to execute a key press response on one of two keys after the illumination of one of two stimulus lights. The stimulus lights are spatially positioned such that one falls to the left and one falls to the right in a display configuration. Observed responses are executed faster when the assignment of light to key is spatially direct (press right key to right light, or left key to left light) compared to when they do not correspond. Therefore, when the assignment of stimulus to response is spatially consistent, the stimulus-response set (S-R) is considered to be compatible (Heister, Schroeder-Heister & Ehrenstein, 1990; Umilta & Nicoletti, 1990). When the assignment of stimulus to response does not

spatially correspond, the S-R set is designated incompatible (Proctor et al. 1992; see Figure 2).

Fitts and Seeger (1953), proceeded with the investigation of S-R compatibility by designing an experimental procedure that allowed them to further probe the translation stage. They proposed that the information contained within the initial presentation of the stimulus set was being translated into a series of mental codes to be utilized during the execution of a task. It was inferred that these mental codes not only held readily observable information, but also contained a vast array of information which was less obvious and more subtle in nature. Fitts and Seeger (1953) suggested if the stored stimulus codes could be manipulated to better mitigate or indicate the response required, the S-R synapse occurring within the translation stage would increase in overall efficiency.

To further probe the translation stage and the predicted S-R compatibility effect, Fitts and Seeger (1953) devised a methodology that required the use of an unique apparatus. The apparatus allowed experimenters to obtain RT measurements and record the number of errors committed by each subjects when making a response. Fitts and Seeger required subjects to quickly and accurately move a stylus in the direction that corresponded to a stimulus light presentation. The experiment used three variants for both it's stimulus and response presentations.

Each of the stimulus and response panel variants were combined to yield nine different combinations of stimulus-response pairings.

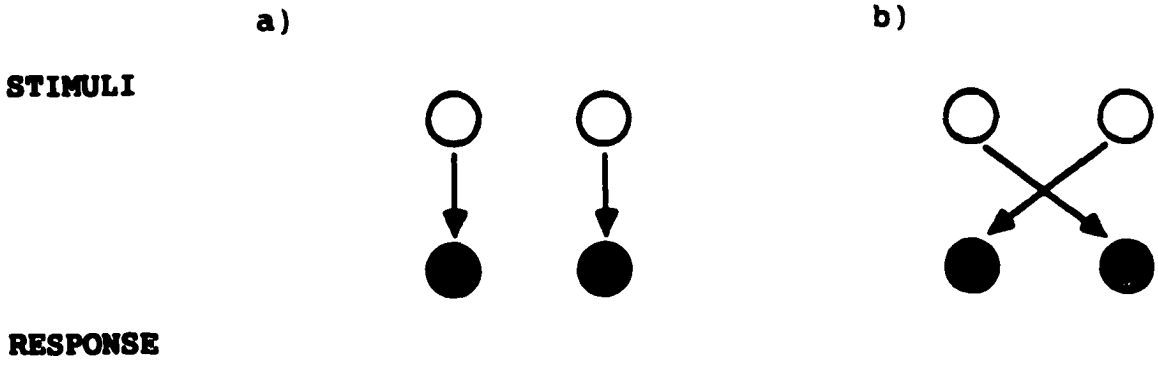


Figure 2. - Stimulus-Response Compatibility In a Two Choice Reaction Time Task; a) Compatible, b) Incompatible.

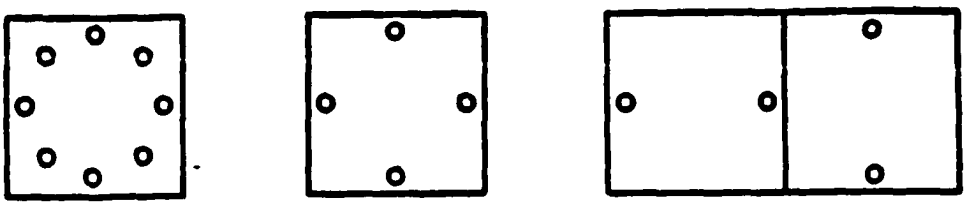
Of the 9 S-R pairings created, 3 sets were judged to display a high degree of physical similarity (see Figure 3).

Fitts and Seeger (1953) predicted that as the degree of spatial correspondence between stimulus and response sets was maximized, it would not only decrease RTs, but also the number of errors being committed during task execution. This deduction suggests that the performer of a task was not only required to store "codes" formed upon consultation with the stimuli, but also information regarding the required response set.

The results of Fitts and Seeger's experiment followed their initial hypothesis in that an increase in the degree of correspondence between the stimulus and response ensembles resulted in a significant reduction in RTs and the number of errors being committed. Fitts and Seeger (1953) concluded that the results "indicate that it is not permissible to conclude that any particular set of stimuli, or set of responses, will provide a high rate of information transfer; it is the ensemble of S-R combinations that must be considered" (p. 209). They also stated that, "this interpretation makes use of the idea of a hypothetical process of information transformation or recoding in the course of a perceptual-motor activity, and assumes the degree of compatibility is at a maximum when recoding processes are at a minimum" (p. 199).

In retrospect, researchers have re-emphasized Fitts and Seeger's (1953) conclusions and generally state that "coded" stimulus information is being internally stored coincidentally with

STIMULUS PANELS



RESPONSE PANELS

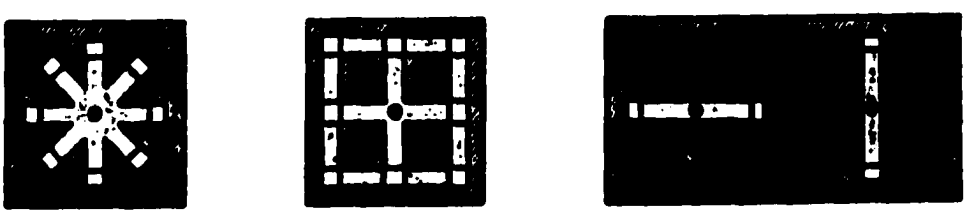


Figure 3. - Fitts & Seeger's Stimulus and Response Panels.

coded response information. Consequently, it is further speculated that as the stimulus codes and the response codes became more aligned or congruent, an increase in the overall proficiency of translation processes occurs (Proctor & Reeve, 1990).

Since the publication of Fitts and Seeger's (1953) seminal study, researchers have continued investigations into this matter by attempting to identify how the information drawn from the immediate environment is coded and prioritized during translation (Proctor & Reeve, 1990).

The Coding of Stimulus and Response Information

As stated previously, many proponents of the information processing model generally agree that perceived extrinsic information is cognitively manipulated and subsequently transformed into a series of neurologically recognizable codes (Heister et al. 1990). However, it is recognized that this process is not only completed for the stimulus presentation, but is coincidentally occurring for the response set. It has been speculated that as information is coded from both the stimulus set and the response set, the process may be influenced in a manner that benefits response execution. Fitts and Seeger (1953), having observed this phenomena state:

> a man's performance of a perceptual-motor task should be most efficient when the task necessitates a minimum amount of information transformation (encoding and/or decoding), in other words, when the information generated by successive stimulus events is appropriate to the set

of responses in the task, or conversely, when the set of responses is appropriately matched to the stimulus set (p. 200).

The factors that have been identified as a major influence on the compatibility of the S-R sets concerns the underlying "features" of each of the two sets (Reeve et al. 1992; Heister, et al., 1990). The term feature, as used by experimenters, is synonymous with characteristic. For example, it has been demonstrated that if the dominant features of the stimulus and the determined response codes possess a high degree of spatial or symbolic correspondence, the execution of the response will be executed with greater efficiency. Reeve and Proctor (1984; 1985) have investigated this phenomenon and demonstrated that it exists across a wide range of choice reaction tasks.

The Initial Reeve & Proctor Studies

Reeve and Proctor's initial investigations (1984; 1985) required subjects to execute a discrete finger movement response by depressing one of four previously designated keys situated on a standard computer keyboard. The decision of which key to press was made by subjects based on the stimuli presented to them on a computer monitor. The stimuli shown to subjects consisted of three horizontal rows of stimuli presented at varying time intervals in the centre of the computer display screen.

The first of the three stimuli rows was designated as the Warning Row. This was comprised of four equally spaced "plus signs" (ie., ++++). Each of these plus signs was spatially aligned

with a response key on the keyboard (from right to left, the "M", "N", "B", and "V" keys). The Warning Row served a dual purpose, as it was designed to indicate the beginning of each trial as well as the four possible response locations.

The second stimulus row, the Precue Row, consisted of either four plus signs or two plus signs. The Precue Row served to "cue" each subject about the position of the response.

In the majority of experiments, four precue conditions were typically used; 1) the Uncued, 2) the Hand-cued, 3) the Finger-cued 4) the Neither-cued (see Figure 4). Each of the "cued" conditions provided the participant with information regarding which of the possible responses was to be completed on that particular trial. The Precue Row was intended to convey vital response information to the subject by reducing the number of possible response choices by 50% (see Figure 4).

The last of the three rows presented was the Target Row and it consisted of only one "plus sign". The presentation of this row was executed at varying time intervals of either 0, 375, 750, 1500, or 3000 milliseconds following precue initiation. The major purpose of the Target Row was to indicate which response was required to successfully complete the trial (see Figure 4). After the presentation of the Target Row, subjects were required to respond as quickly and accurately as possible to the target.

The first of Reeve and Proctor's 1984 series of experiments was undertaken to consider alternate explanations of Miller's (1982) Experiment 1. Miller's procedure had revealed that a precue

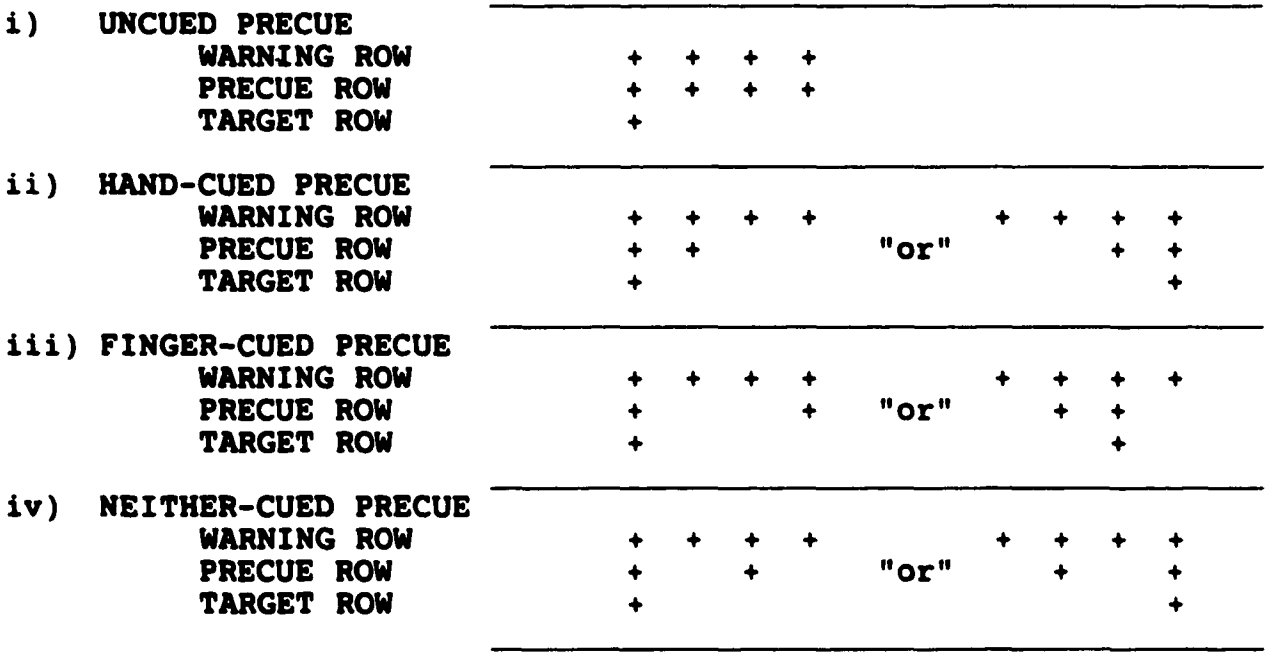


Figure 4. - Precues Used by Reeve & Proctor (1984).

advantage existed when paired precue stimuli were presented such that they indicated that the response required would occur in one of two target locations assigned to the same hand. Miller being consistent with his results as well as Rosenbaum's (1983) theories, went on to postulate that the same hand advantage was attributable to "motoric factors" and/or the lateralization of the nervous system. Reeve and Proctor argued that if Miller's hypothesis was correct, the advantage observed should remain consistent with any increased precue duration. However, as Reeve and Proctor illustrate, they failed to provide an adequate precue delay interval for the same hand advantage to be extinguished. To further test their prediction, Reeve and Proctor (1984) conducted an experiment in which the precue delay interval was manipulated using five time variants ranging from 0 to 3000 milliseconds. Reeve and Proctor (1984) confirmed that significant differences did exist between precue intervals and preparation conditions. However, the pattern of RTs for all preparation conditions revealed that the Hand-cued precue was superior as long as precue delays were held below 1500 milliseconds. Indeed, the pattern of differential precuing effects among preparation conditions held up even when preparation delays were eliminated (0 millisecond precue delay intervals). Reeve and Proctor also observed the existence of an interaction between precue interval and preparation condition. Therefore, it was shown that Miller's design was flawed due to the fact that he had failed to include sufficiently long precue delay intervals. After examining the discrepancy between their research

and Miller's, Reeve and Proctor (1984) suggested the advantage observed was the result of internal processes occurring within stimulus-response translation.

Having observed the superiority of the Hand-cued precue, Reeve and Proctor (1984) designed a second study which would scrutinize and further examine why the Hand-cued precue continued to yield an advantage even when the precue and target were simultaneously presented. Reeve and Proctor decided to further probe the precue effect by limiting the delay to 0 milliseconds or 3000 milliseconds across all preparation conditions. Consequently, two groups were established, one group received simultaneous presentation (0 millisecond precue delay) of precue and target in 20% of their trials, while another group received simultaneous presentation in 80% of the trials. It was predicted these two groups would demonstrate differences in their RT precue pattern due to the existence of an interference effect being established in the 20% simultaneous grouping.

Results of the investigation indicated that the effect was indeed established in the 20% simultaneous group but was absent in the 80% simultaneous group. The results were taken as support for the interference postulate, and provided further credibility to the hypothesis that differences exhibited between precue conditions are attributable to "non-motoric" factors involving stimulus-response translation.

With the support from this second experiment, it was established that the superiority of the Hand-cued precue was a

function of the translation stage and not due to response programming as Miller (1982) had suggested. It was inferred that response preparation was not the source of the advantage as it was still present even when targets and precues were presented together allowing for virtually no preparation time. Reeve and Proctor restated that the cognitive decision making process was responsible for the differences observed when relatively short precue delays were utilized and not any characteristic of response programming (a "motoric" explanation). If this was the case, then the validity of Miller's experimental technique had to be re-evaluated as it would no longer be considered an appropriate tool for examining the inherent characteristics of response preparation (e.g, continuous vs. discrete models of human information processing).

Reeve & Proctor's (1984) third experiment was designed to distinguish between "motoric" or "non-motoric" factors in the precuing task. The new experimental procedure, designed to address the two different interpretations, included the introduction of two hand placement styles. Subjects in the Adjacent hand placement group situated their fingers in a spatially direct fashion with the left middle finger falling on the "V" key, the left index finger placed on the "B" key, the right index finger on the "N" key and the right middle finger situated on the "M" key (see Figure 5).

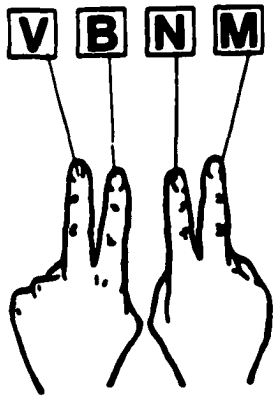
The subjects in the Overlapped hand placement group were split into two equal sub-groups. One of these sub-groups situated their hands in such a position that their left hand was laid over their right, while in the other subgroup, the right hand was placed over

the left. Either version of this hand placement dictated that the fingers be placed in a manner that allowed the right index to be placed on the "V" key with the left middle finger falling on the "B" key, the right middle on the "N" key and the left index on the "M" key (see Figure 5).

The results of Reeve and Proctor (1984; Experiment 3) study clearly demonstrated the existence of an advantage for a precue denoting either the two left-most locations or the two right-most locations, regardless of the hand placement used. More specifically, the Hand-cued precue in the Adjacent hand placement, and the Neither-cued precue in the Overlapped hand placement yielded superior RTs relative to the other precue conditions. The varying results obtained for each precue condition were interpreted by Reeve and Proctor as reflecting differing relative levels of salience within each of the spatial feature orientations elicited by the various precue conditions. This "non-motoric" interpretation was seen to be in direct opposition to the postulate of "motoric" advantages put forward by Miller (1982).

Throughout Miller's (1982) investigations, he proposed that the precue pattern obtained was solely the responsibility of the inherent characteristics of the motor system. Miller argued that when individuals formulated a "plan of action" they went through a ritual of selecting movements (motor-components) required in the task utilizing a preset hierarchialistic pattern. Therefore, Miller's earlier account attributed the precue advantage to "motoric" factors involved in the generation of a movement

a)



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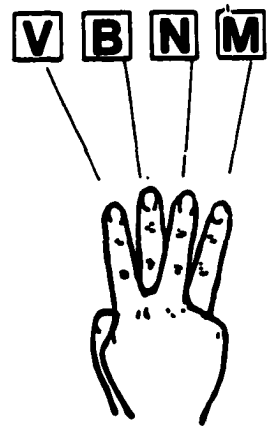


Figure 5. - The Hand Placements Used By Reeve and Proctor (1984); a) Adjacent, b) Overlapped.

execution plan occurring during the response programming stage of processing.

Reeve and Proctor (1984), with the use of their unique Overlapped hand placement, were able to dissociate the spatial relations of the stimuli and response positions from that of the preparation conditions (Reeve & Proctor, 1985). The results produced in their 1984 study, which used the Overlapped placement, clearly demonstrated that hand distinction was not responsible for the differential precuing trend. Rather, it was the spatial S-R relations that were the major contributor. This "non-motoric" interpretation was also supported by the results of their 1985 study which used a similar procedure utilizing symbolic stimuli. These results, have contributed to the development of the Salient Feature Coding Principle.

The Salient Features Coding Principle

Recently, Reeve and his colleagues have proposed that the translation stage operates in compliance with a Salient-Features Coding (SFC) principle. Restated by Reeve et al. (1992):

> according to the principle, response efficiency is a function of stimulus-response (S-R) translation processes that operate on mental codes formed to represent the sets of stimuli and responses. These codes are based on the salient features of the respective sets, with responses being fastest and most accurate when the features correspond (p. 453)

In other words, a response will occur with a higher degree of

efficiency (a RT benefit) when the salient features of the stimuli and the response sets are highly aligned or congruent. According to Reeve and his colleagues, salience refers to the most apparent or dominant feature contained within the stimuli set and/or the response ensemble. In addition, stimulus and response sets are composed of a number of features which provide information in accordance with a predetermined hierarchial arrangement based on the relative salience of the features contained within each set.

Manipulation of Salience

Recently, Reeve et al. (1992) applied the logic of the salient features coding principle to establish a baseline from which to examine the influence of organization manipulations of the stimulus and response sets (S-R sets). In three experiments, using the four-choice spatial precuing task, Reeve et al. actively manipulated the relative salience for the spatial features of the S-R set by appealing to the Gestalt Laws of Grouping (e.g. Koffka, 1935/1963; Pomerantz & Kubovy, 1986). In their Experiments 1 and 2, stimuli and responses were grouped according to spatial proximity, whereas in the third experiment, the stimulus set was grouped on the basis of similarity (see Figure 6).

Following the Gestalt Laws of Grouping, Reeve et al. (1992) designed a number of spatial variants of the four-choice precuing paradigm. Specifically, subjects in their experiment 1 were required to respond to a stimulus presentation that was either presented in a "Together" format or a "Separated" format. In addition, the response ensemble was co-manipulated and subjects

a) Proximity

b) Similarity

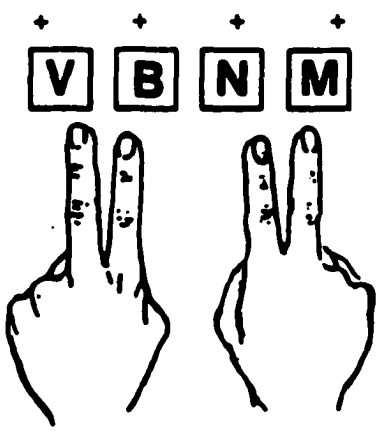
Figure 6. - Examples of the Gestalt Laws of Grouping a) Proximity, and b) Similarity.

were required to execute their responses with their hands placed in a "Together" arrangement or a "Separated" arrangement (see Figure 7).

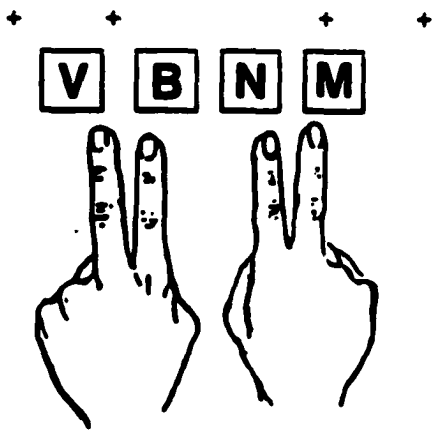
Results indicated that, for all conditions that involved the standard stimulus display, the order of differential precuing benefits were consistent with the results of previous studies (Reeve & Proctor, 1984). That is, the Hand-cued precue condition yielded the fastest RTs and the Finger-cued condition produced significantly slower times. The Neither-cued condition tended to yield intermediate times and the Uncued condition produced the slowest times overall.

The pattern of differential precuing benefits for the Separated display was significantly different than that obtained with the Together display. The Separated display produced the fastest RTs for the Hand-cued precue. In fact, the times generated were even faster than those obtained with the Together display. However, the typical differences between the Finger-cued and the Neither-cued conditions were eliminated, thereby producing highly similar scores for these two preparation conditions. The Uncued condition, following suit with all earlier investigations, yielded the slowest RT scores overall. Finally, it was noted that when the Together display was used in conjunction with the hands apart response condition, the percentage of error was greater than when the hands together paradigm was utilized. This trend would seem to add further credibility for the use of Gestalt Laws of Grouping when manipulating salience.

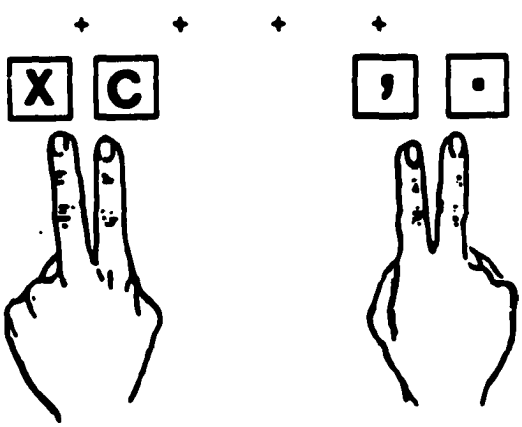
a) Display Together
Hands Together



b) Dislay Separated
Hands Together



c) Display Together
Hands Separated



d) Display Separated
Hands Separated

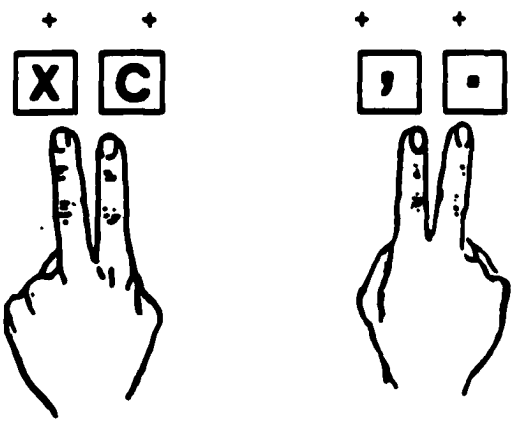


Figure 7. - Stimulus and Response Set Manipulations Following The Gestalt Law of Proximity (Reeve et al. 1992).

The results obtained in Reeve et al. (1992) study are understood to be direct function of the relative degree of spatial organizational correspondence between the presented stimuli and the participants responses. The left-right feature bias exposed in the latter study (and previous investigations) is thought to be a function of this direct organizational correspondence between the stimuli and responses.

The differences in the pattern of RT benefits between the two display types was first suggested by the authors to be directly attributable to the initial stimulus identification stage and not the translation process. However, upon a closer examination, this suggestion was later rejected by Reeve and his associates (1992), as it became more evident that salience of the left and right locations of the stimuli had been positively influenced solely through the use of the Separated display. Subsequently, this was interpreted to be responsible for the increased efficiency of the translation stage.

In the third experiment, Reeve et al. (1992) attempted to expand and enhance the stimulus set to further exemplify the newly discovered relations exhibited in the previous experiment. It was postulated that, if they could further increase the relative salience of the features contained in the stimulus set with the use of a "Similarity" grouping scheme, it would initiate a direct biasing effect on the response ensemble. The third experiment was also conducted to further demonstrate that the salient features are a major contributor to the observed dominance of the left-right

response characteristic recognized in the previous investigations.

This experiment involved 128 subjects randomly assigned to one of two groups. Each group was then assigned a particular hand placement (Overlapped or Adjacent). Within each hand placement grouping, subjects were randomly divided into four different sub-groups consisting of 16 subjects. Each of these sub-groups was then tested once for each of the four display organizations used in the experiment. The display organizations consisted of; 1) the Control display in which all characters utilized were either "+" signs (++++) or "o" signs (oooo), 2) the Left-Right display, which was comprised of "+" signs and "o" signs which were presented at either the two left-most locations or the two right-most locations, 3) the Inner-Outer display, in which the "+" and "o" characters were displayed at either the two inner or two outer spatial locations, 4) the Alternate display, where the four locations were represented by two symbols in an alternating fashion (see Figure 8).

The results of the study indicated that there was a significant interaction between hand placement and precue type. This interaction directly corresponds to the earlier results of Reeve and Proctor's (1984) study and reaffirmed the early finding that, precue benefits are determined by spatial location (Reeve et al, 1992). In addition to this finding, the researchers also noted the presence of the typical main effect of hand placement as well as the classic interaction between hand placement and preparation condition (precue type). These prototypical results have been

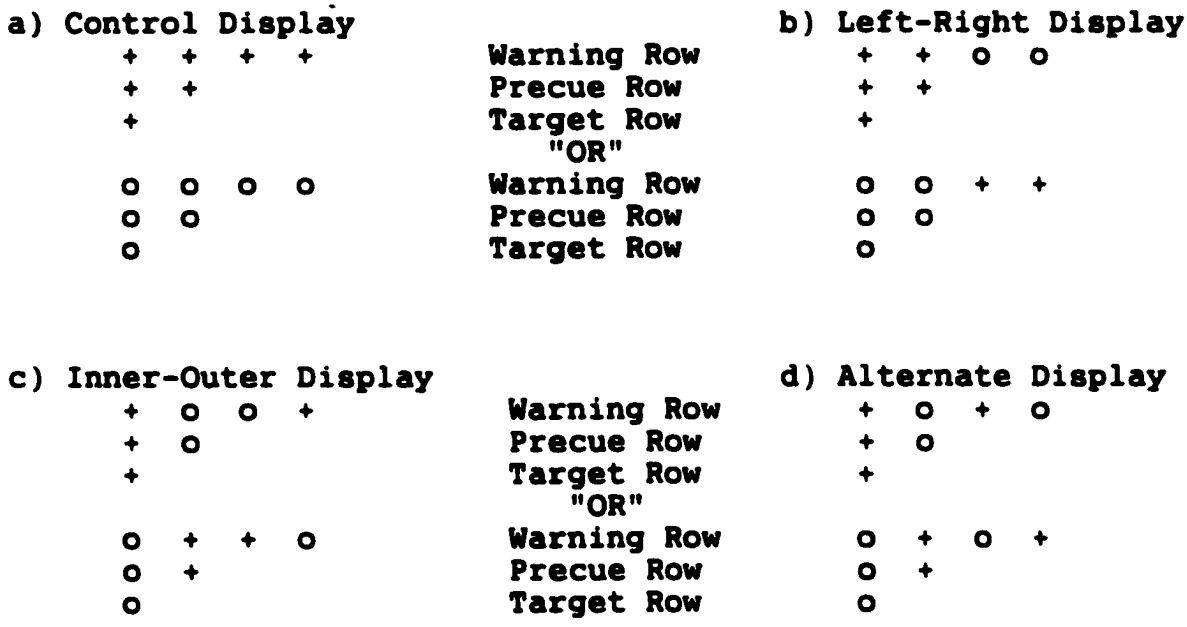


Figure 8. - The Eight Different Display Manipulations Used by Reeve, Proctor, Weeks and Dornier (1992).

demonstrated to occur consistently across all studies as the order of the precue conditions' RTs are deemed to be a direct function of the precued spatial locations and not the particular finger used when responding. Along with these latter results, the typical effect of precue interval was also significant.

Display organization did not interact significantly with the precue conditions even though the individual pattern of RTs of the four displays varied. Although the interaction did not reach a conventional significance level, an advantage was noted for all precue conditions across both hand placements when the Inner-Outer and the Left-Right display organizations were compared to the Control and Alternate display conditions. A follow-up analysis was conducted to further probe the marginally significant three-way interaction between display organization, precue and hand placement. When the Adjacent hand placement was utilized, the differences between the Left-Right and the Inner-Outer display organizations in the Uncued and Hand-cued precue conditions were minuscule (14 & 16 milliseconds, respectively). Alternatively, the differences between the Finger-cued and Neither-cued were on the average 35 milliseconds faster for the Inner-Outer display organization when compared against the times of the Left-Right display grouping. This same type of relation was again present when the Overlapped hand placement was introduced into the procedure. It was observed that the Left-Right and the Inner-Outer display organizations produced the fastest times overall regardless of precue condition. However, once again, the advantage for the

alternating and inner-outer precued response locations was the dominant feature of the relation between the two. From these results, Reeve et al. (1992) concluded that the manipulation of the Similarity Grouping (display organization) had little effect when based on the alternate locations. Therefore, the Similarity Grouping manipulation was deemed to provide an added coded feature that emphasized locations which are not normally salient.

Purpose of the Thesis

Overall, and in agreement with the salient features coding principle, Reeve et al. (1992) observed a systematic alteration of the pattern of precuing benefits as a function of the pairings of elements made salient by the organizational manipulations. However, we would argue that the manipulations of the response set were limited primarily to their Experiment 1. In light of the fact that the proximity grouping of the response set had little apparent influence on RTs, Reeve et al. (1992) concluded that manipulations of the stimulus set salience were more effective than were response manipulations.

However, this conclusion may be somewhat premature given that the organizational manipulations applied to the stimulus set were considerably more elaborate than those applied to the response set. Specifically, whereas the stimulus set manipulations involved both spatial and intrinsic stimulus features, the response set manipulations were limited to spatial features only (ie. proximity and hand placement). Indeed, Reeve et al. (1992) acknowledged that the response set manipulations used in their study were relatively ineffective but suggest that other manipulations may prove to be more effective. Thus, the purpose of the present experiments were to further assess whether organizational features of the response set can be manipulated to influence the coding operations of the translation stage in a manner consistent with the salient features coding principle.

Experiment 1

Experiment 1 was a direct follow-up to Reeve et al. (1992, Experiment 1). In that experiment, the horizontal structure of the sets was similar to previous studies using the four-choice spatial-precuing task (e.g. Reeve & Proctor, 1984). However, the roles of absolute and relative spatial correspondence were examined by a factorial manipulation of the proximity of the elements in the stimulus and response sets. As in Experiment 1 of Reeve et al., two spatial arrangements were used for stimulus set in the present experiment. The Together arrangement used four equally spaced stimulus locations, whereas the Separated arrangements used two locations to the left and two locations to the right of a central gap (see Figure 9).

For the response set, the present study adopted the standard Adjacent hands placement used in previous work. Rather than employing a spatial proximity grouping manipulation, the response set manipulation was achieved through the use of textured keys (see Figure 10). Responses should be fastest overall when the organizing features of the stimulus set (spatial) and their response set (tactile) correspond. In particular, if separating the stimulus arrangement and the response set manipulation increases the salience of the left-right feature, then the advantage for the left-right precues relative to the other precue conditions should increase.

Method

Subjects. Subjects consisted of 32 undergraduate volunteers.

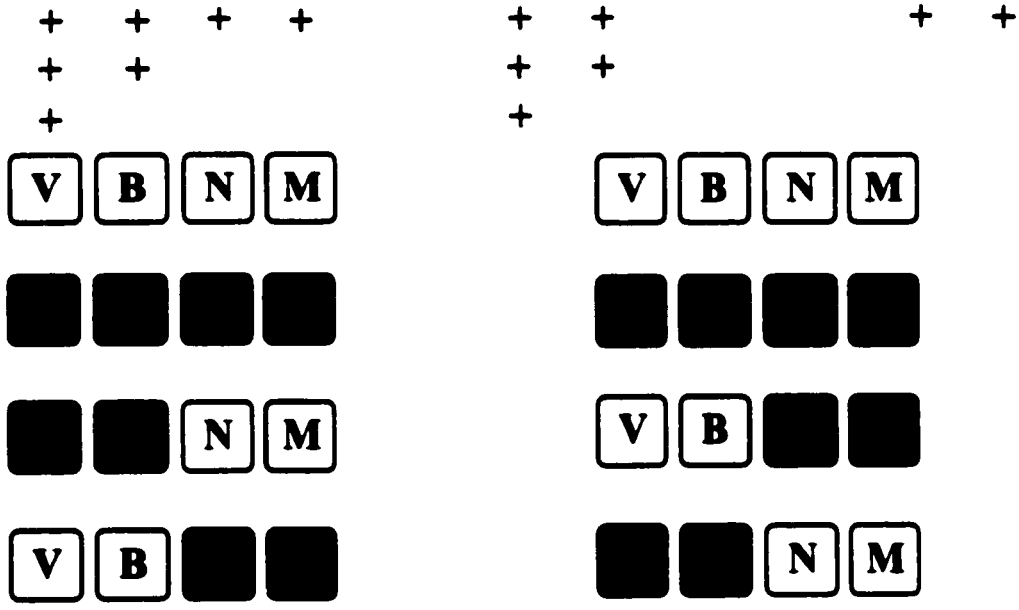


Figure 9. - Stimulus and Response Sets Used in Experiment 1. Shaded Keys Denote the Placement of Textures.

All were naive to reaction time experimentation.

Apparatus and Stimuli. The stimuli were presented on a SVGA computer monitor interfaced with an IBM 486 microcomputer. All stimulus materials, trial and temporal parameters, and response measures were controlled and recorded by software generated using the Micro Experimental Laboratory (MEL) system.

The stimulus array consisted of 3 horizontal row of plus signs (+), separated vertically from each other by 5 millimetres (mm). The first row (Warning Row) consisting of 4 plus signs, specified the 4 possible response locations. The second row (Precue Row) consisted of 2 to 4 plus signs and delimited the number of possible responses to two. The last row (Target Row) consisted of a single plus sign indicating the imperative response location.

The response keys were the "V", "B", "N", and "M" keys on a QWERTY key board. For response set manipulation, 80 grit coarse sandpaper (20 mm x 17 mm) was applied to the surface of the appropriate response keys.

Procedure. Subjects were seated facing a computer monitor, with their mid-line aligned with that of the computer monitor. The monitor was located approximately 50 centimetres (cm) away from each subject. Each subject performed two blocks of 310 trials. Subjects were permitted a 10 minutes rest interval between blocks. The first 30 trails for each block was considered practice and were excluded from the analysis.

Subjects placed their left index and middle fingers on the "B" and "V" keys, respectively, and their right index and middle

fingers on the "N" and "M" keys, respectively. Subjects were instructed to respond as quickly and accurately as possible.

A trial began with the presentation of the Warning Row. Following an interval of 1000 milliseconds (ms), the Precue Row appeared on the screen. The Target Row appeared following an interval of 0, 375, 750, 1500, or 3000 ms.

The precue provided advance information delimiting the number of possible response locations. Their were four precue conditions: a) an Uncued condition, in which no additional information was provided (all four locations were cued), b) a Hand-cued condition, in which the two fingers for a single hand were cued, c) a Finger-cued condition, in which the two index or two middle fingers were cued, and d) a Neither-cued condition, in which the index finger of one hand and the middle finger of the other hand were cued.

The stimulus ensemble was presented in two possible configurations: a) Together or, b) Separated. In the Together arrangement, stimuli were presented at the centre of the screen with each plus sign equally space from one another. In the Separated arrangement, stimuli were again presented centrally, with two equally spaced plus signs on each side of a central gap measuring 6 centimetres.

The response set manipulation involved changing the texture of the response keys. This was achieved with the use of pieces of sandpaper adhered to the keys. Two response set configurations were employed: a) an Unorganized response set, in which all keys were either smooth or textured, and b) an Organized response set,

in which textured keys were arranged to correspond with the separated response sets used by Reeve et al. (1992). This required either the two-left most or the two right-most keys to be textured and the other two keys to be smooth.

The 32 subjects were randomly assigned to two equal groups. The first group was designated as the Unorganized response group, and was further divided such that half of the subjects used all smooth keys and the other half used all textured keys. The second group was designated as the Organized response group and was also subdivided such that half the subjects executed their responses with the two left-most keys textured and the other half with the two right-most keys textured. All subjects performed under both the Together display and Separated display conditions.

Experiment 1 thus employed a 2 x 2 x 4 x 5 (Response Organization x Display Organization x Precue x SOA Interval) mixed factorial design with repeated measures on the last three factors.

Mean RTs and the number of errors were recorded with respect to Response Organization, Display Organization, Precue and SOA Interval.

Results

Reaction Time Analysis. Analysis of reaction times revealed significant main effects for the Precue condition $F(3, 90)=76.2$, $p<.001$ and SOA Interval $F(4, 120)=87.1$, $P<.001$.

Reaction time means for the Uncued condition were 530 ms, 475 ms for the Hand-cued condition, 525 ms for the Finger-cued condition and 536 ms for the Neither-cued condition. The main

effect of Precue is a very robust finding and has been consistently found to be significant in previous research which utilized the same precuing procedure (Proctor & Reeve, 1988; Reeve & Proctor, 1984). Traditionally, the Hand-cued condition yields the fastest responses, the Neither-cued and Finger-cued intermediate responses, while the Uncued condition produces the slowest responses.

The mean RTs for the significant main effect of SOA Interval were 612 ms for the 0 ms delay, 507 ms for the 375 ms delay, 506 ms for the 750 ms delay, 489 ms for 1500 ms delay and 469 ms for the 3000 ms delay. These results represent an overall decrease in RTs as the SOA Interval increases. Again, this is a typical finding of this type of research (e.g., Proctor & Reeve, 1988, Reeve & Proctor, 1984). Moreover, this outcome suggests the longer an individual has to prepare for an impending response, the more efficiently their response will be executed. However, Magill (1989) suggests this trend would not continue indefinitely. He states that there is an optimum preparation time between 2 and 4 seconds in which this effect will be maintained. Once preparation time exceeds a 4 second duration, it is suspected the benefits observed will begin to be extinguished.

The SOA Interval x Precue Interaction was also found to be significant during analysis, $F(12, 360) = 12.1$ $p<.001$ (see Table 1 & Figure 10). Results of earlier studies also consistently find this interaction to be significant (Reeve & Proctor, 1984; Reeve et al. 1992). The interaction reflects an increased benefit for the Hand-cued condition beyond SOA Intervals of 0 ms. The interaction

Interval	0	375	750	1500	3000
Uncued	597	513	514	520	509
Hand-Cued	572	457	460	450	439
Finger-Cued	638	526	519	483	462
Neither-Cued	643	533	531	502	472

Table 1. - Mean Reaction Times for Interaction of SOA Interval x Precue.

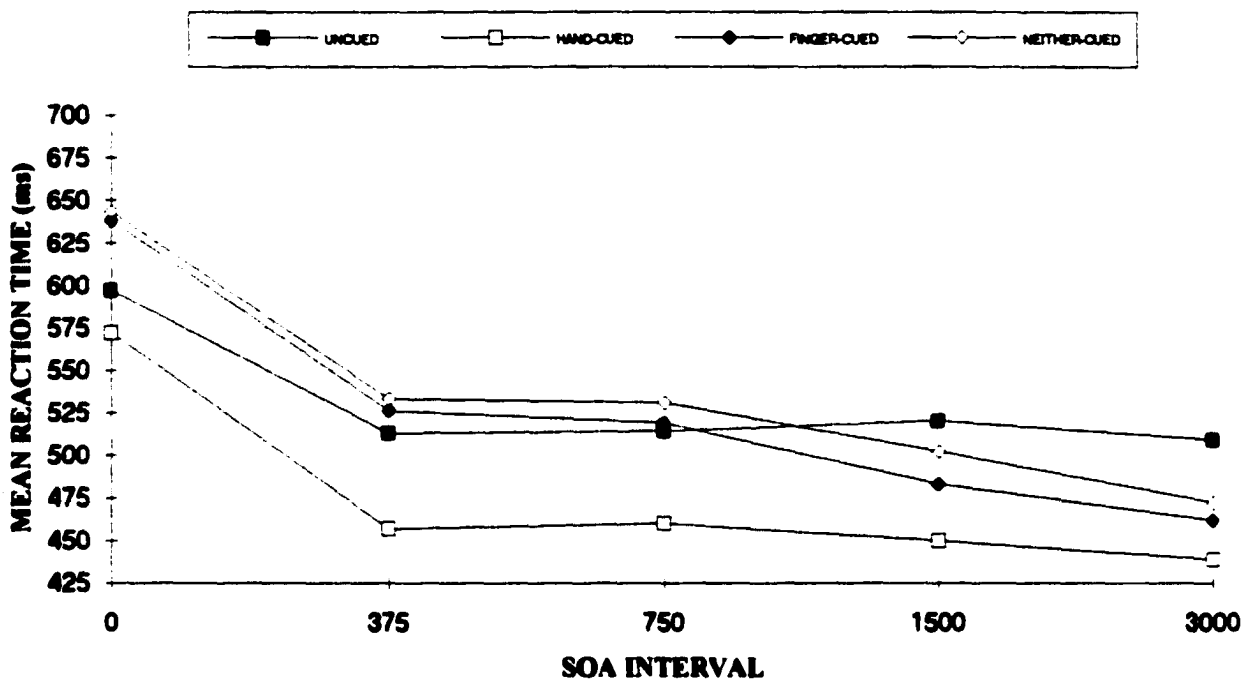


Figure 10. - Two-way Interaction of SOA Interval x Precue.

demonstrates the trend that the increased benefits seen in RTs for all precued conditions extinguishes as the duration of the interval increases.

The Display Organization x Precue Interaction was also significant, $F(3, 90) = 5.1$ $p<.005$. As shown in Figure 11, the interaction primarily reflects a change in the RT pattern for the Finger-cued condition. Specifically, when the Together display organization was used, the results obtained were similar to that typically obtained using the four-choice precuing procedure. However, separating the display had the effect of eliminating the benefit for the Finger-cued condition and equating the same two conditions for which precues designated locations on both sides of the display (Finger-cued & Neither-cue; see Figure 11).

A three way interaction of Display Organization, Precue, SOA Interval was observed to be significant, $F(12, 360) = 1.9$ $p<.05$. This interaction demonstrates that the advantage for the precued conditions relative to the uncued conditions increased across SOA Intervals at somewhat different rates for the two display organizations. The typical convergence of RTs at the longer SOA Intervals that were observed for the Together Display was limited to only the 3000 ms SOA Interval for the Separated Display (see Figure 12). Overall, these results are highly consistent to those obtained by Reeve et al. (1992).

Error Analysis. Analysis of error scores revealed significant main effects of Display Organization, $F(1, 30) = 5.8$ $p<.05$, Precue, $F(3, 90) = 16.2$ $p<.001$, and SOA Interval, $F(4, 120) = 4.1$ $p<.005$.

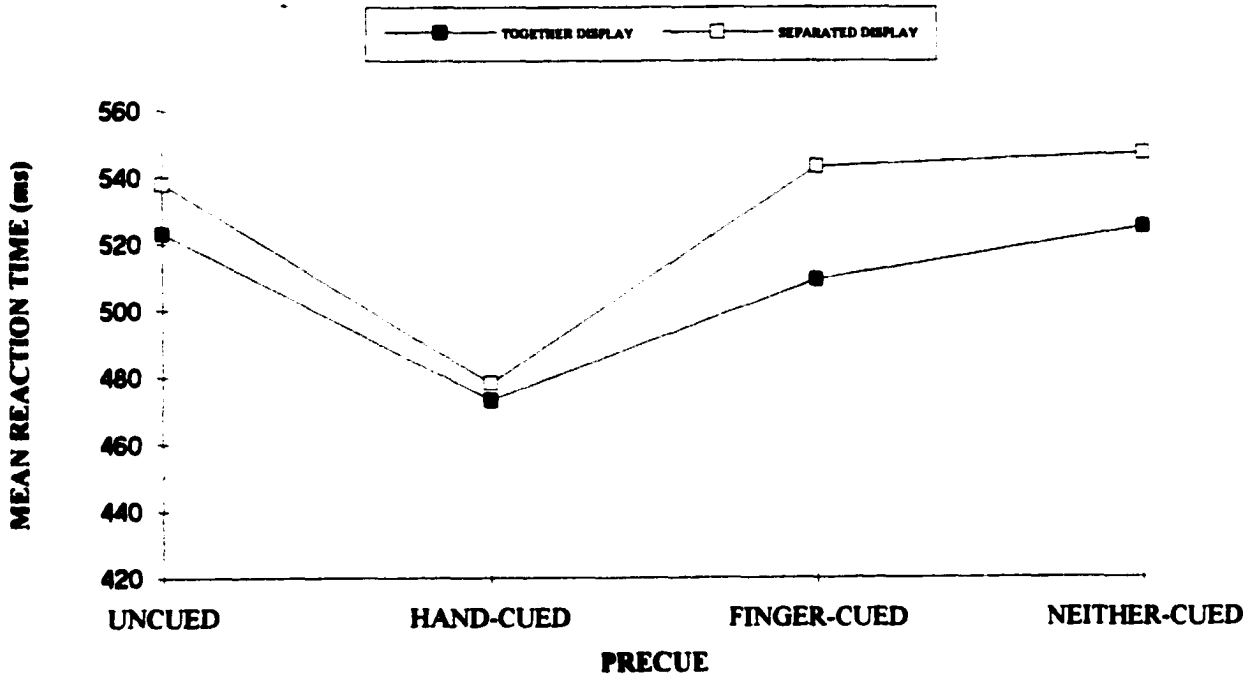


Figure 11. - Reaction Times for the Interaction of Display Organization x Precue.

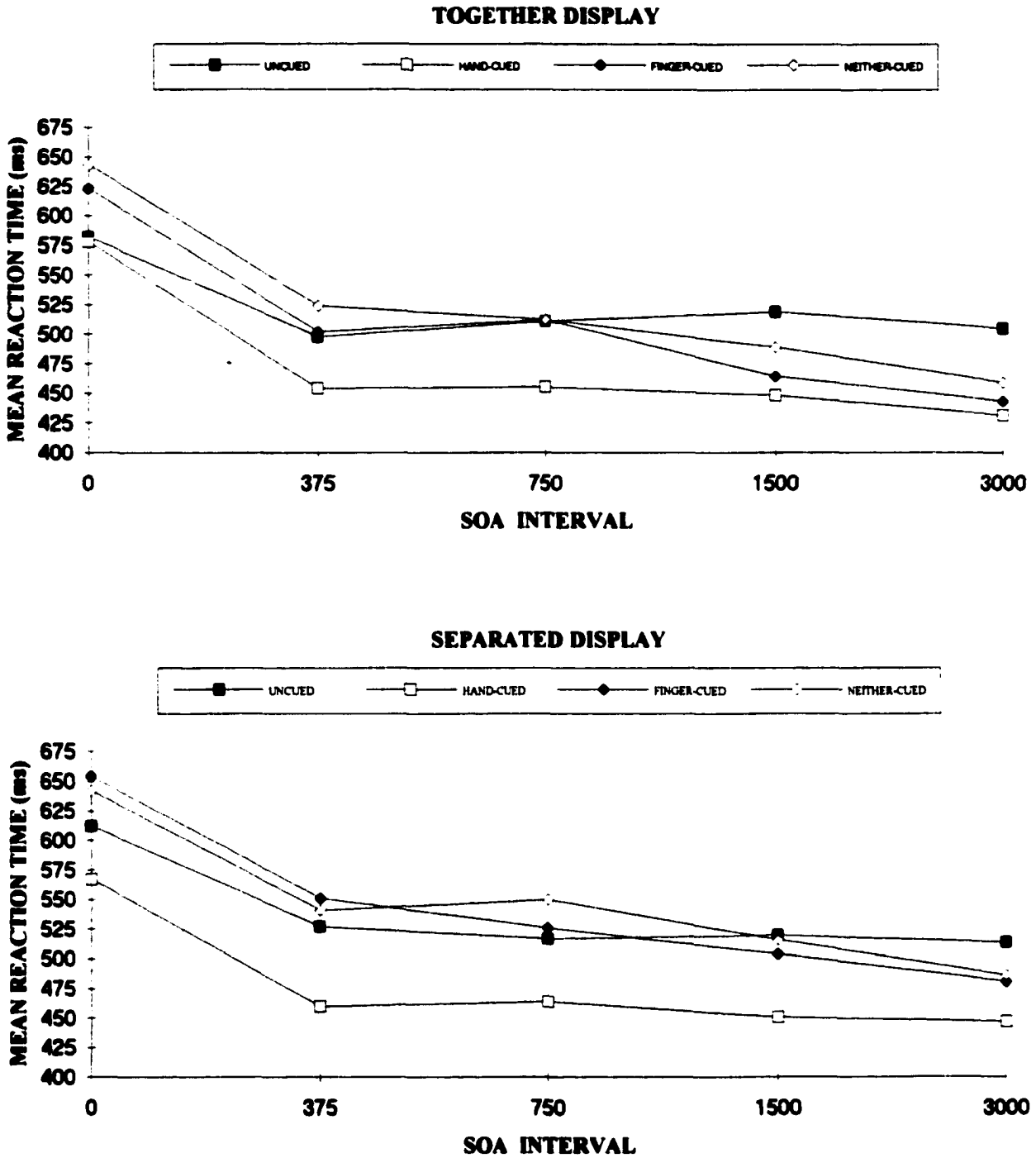


Figure 12. - Display Organization x Precue x SOA Interval Interaction.

The main effect of Precue demonstrates an increased response accuracy for all the precued conditions. Specifically, the Hand-cued condition with a mean percentage error of 3.06 showed the greatest benefit. The Finger-cued and Neither-cued precue presentations produced intermediate error scores of 4.94% and 5.06%, respectively. Moreover, the Uncued precue yielded the greatest number of errors with 5.08 percent error. Again, these results are consistent with earlier research which used the same precuing paradigm (Proctor & Reeve, 1988; Reeve & Proctor, 1984; Reeve, Proctor, Weeks & Dornier, 1992).

The main effect of SOA Interval manipulation also produced percent error scores consistent with earlier studies (Proctor & Reeve, 1988, Reeve & Proctor, 1984, Reeve, Proctor, Weeks & Dornier, 1992). The SOA Intervals of 0 ms, 375 ms, 750 ms, 1500 ms, and 3000 ms conditions produced error scores of 6.89%, 5.59%, 3.88%, 3.20% and 3.22%, respectively. These results reflect a general increase in response accuracy as the SOA Interval between precue presentation and the target presentation increased. This effect is consistent with the view that when the duration between a precue and it's required response is increased, it enhances the overall effectiveness of information processing by providing additional time for information processing to occur. In addition, if the fore period is long enough, it provides an opportunity for response planning to be initiated. The combination of these processes results in an overall decrease in the number of errors being committed by providing sufficient time for an individual to

prepare for the impending response.

The main effect of Display Organization was also found to be significant. The mean percentage error produced using the Together Display was 3.72%, while the Separated Display configuration yielded a mean percentage of error of 5.35%. It has to be noted that when responding, subjects were required to keep their effectors in a position which spatially corresponds to a greater extent with the Together Display organization as compared to the Separated Display organization.

No interactions in the error analysis were significant in the current study, but the Display Organization x Response Organization Interaction approached significance $F(1, 30) = 2.8$, $p<.10$ (see Figure 13). This result is consistent with Reeve et al. (1992).

Discussion

For both response arrangements, a pattern of differential precuing benefits typical of the four-choice precuing task was observed when using the Together Display organization. Specifically, responding was fastest for the Hand-cued condition, intermediate for the Finger-cued condition, and slowest for the Neither-cued condition. However, the pattern of precuing benefits observed when using the Separated Display organization was somewhat different. When the Separated Display was used, reaction times for the Finger-cued and Neither-cued did not differ. In addition, the observed RT difference between the Hand-cued and Finger-cued was greater. In sum, partitioning the display set cancelled the precuing benefit for the inner-outer locations (Finger-cued

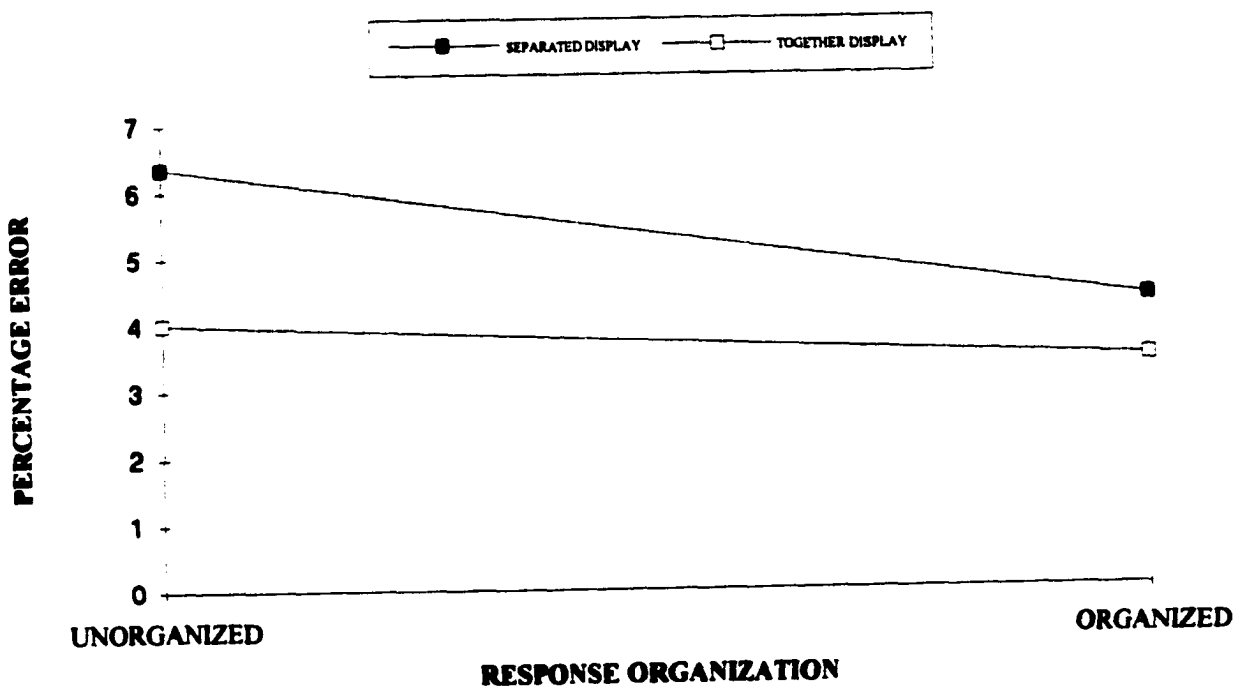


Figure 13. - Display Organization x Response Organization Interaction.

condition) relative to the alternate locations (Neither-cued condition). Consistent with Reeve et al. (1992), the results of the present experiment indicate that manipulating the organizational features of the stimulus set can influence the pattern of precuing benefits.

Experiment 2

In Reeve et al. (1992, Experiment 3), stimulus set organization was manipulated according the Gestalt principle of similarity grouping of the elements (Pomerantz & Kubovy, 1986). Using the Together Display, stimulus groupings were defined through the use of "+" and "o" characters. The organizational manipulation involved designating the four stimulus locations with two each of the characters, thereby allowing pairs of locations to be grouped by a common character. A further manipulation in the study involved the use of both Adjacent and Overlapped hand placements that were used in previous experiments to dissociate fingers from spatial locations (e.g. Cauraugh, 1990).

Two primary findings were obtained in the Reeve et al. (1992) study which are consistent with the salient features coding principle. First, because the horizontal stimulus-response (S-R) arrangement used in the 4-choice spatial precuing task promotes a salient left-right spatial feature, the typical benefit for precuing the left or right pairs of locations was evident for all displays and hand placements. More importantly, similarity grouping was effective in providing an additional benefit for precue locations that typically are not salient.

Experiment 2 was a direct follow-up to Reeve et al. (1992; Experiment 3). The response set manipulations used in the present experiment mirrored the stimulus set manipulations used in their Experiment 3. As in Experiment 1 of the present thesis, features of the response set were manipulated through the use of textured keys.

Method

Subjects. Subjects consisted of 128 undergraduate volunteers.

Apparatus and Stimuli. The apparatus were similar to those in Experiment 1. The stimulus configuration was identical to the Together Display in Experiment 1.

Procedure. The 128 students were randomly assigned to two equal groups. Sixty-four subjects were placed in the Adjacent hands placement group and the other 64 subjects were placed in the Overlapped hands placement group. For the Adjacent hands placement, the left to right ordering of fingers was left middle, left index, right index, and right middle. For the Overlapped hands placement, the order was right index, left middle, right middle, and left index. The response keys used were "V", "B", "N", and "M" keys on a QWERTY keyboard. For the response set manipulation, 80 grit sandpaper (20 mm x 17 mm) was applied to the appropriate response keys.

Within each of the two hand placement groups, the subjects were subdivided into four equal groups (n=16), each assigned to one of four texture configurations. These texture configurations were: 1) a Control, in which all keys were either all smooth, or textured; 2) a Left-Right configuration, in which the two left-most keys or the two right-most keys were textured; 3) an Inner-Outer arrangement, in which the 2 inner-most keys or the two outer-most keys were textured; 4) an Alternate arrangement, in which the response keys were textured alternately, with the "V" and "N" keys textured or the "B" and "M" keys textured (see Figure 14).

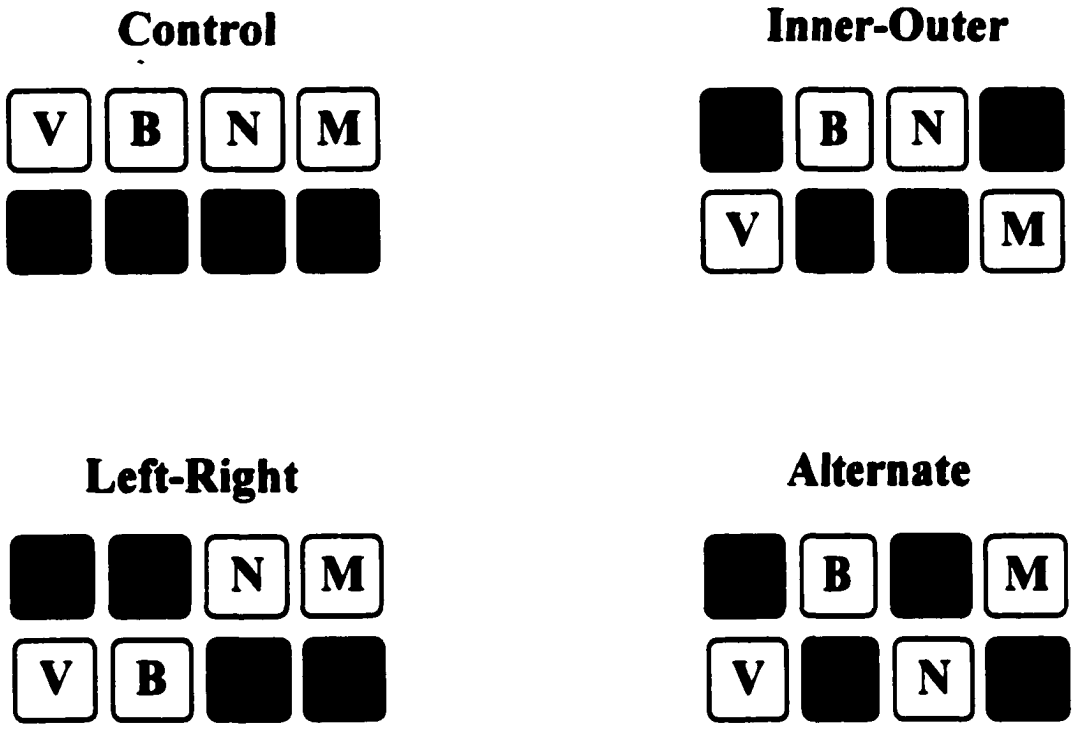


Figure 14. - Response Sets Used In Experiment 2. Shaded Keys Indicate Texture Placements.

The group of 16 subjects within each texture configuration was again equally divided and assigned to 1 of 2 arrangements within each configuration.

The precue types in Experiment 2 were identical to those used in Experiment 1. Again, these were the; a) Uncued, b) Hand-cued, c) Finger-cued and d) Neither-cued. Note, however, that with the introduction of the Overlapped hands placement, the information provided by the Hand-cued and Neither-cued precue types is changed. With the Adjacent hands placement, the relation of the precues to responses was identical to that in Experiment 1. With the Overlapped hands placement however, the Hand-cued precue indicated that a response was required by either the index or middle finger belonging to the opposite hands. Also, the Neither-cued precue dictated that the response be executed by either the index or middle finger of the same hand.

The remaining procedures were similar to those of Experiment 1. Experiment 2 employed a 2 x 4 x 4 x 5 (Hand Placement x Texture Organization x Precue x SOA Interval) mixed factorial design with repeated measures on the last 2 factors. Each subject performed a single set of 310 trials. The first 30 trials were considered practice and excluded from the analysis.

Results

Reaction Time Analysis. Analysis of reaction times revealed significant main effects for Hand Placement $F(1, 120) = 109.8$, $p<.001$, Precue $F(3, 360) = 5.4$, $p<.001$ and SOA Interval $F(4, 480) = 25.5$, $p<.001$.

With respect to the main effect of Hand Placement, the Adjacent hand placement produced faster mean RTs than the Overlapped hand placement. The mean RT of the group of subjects who used the Adjacent hand placement was 520 ms. In comparison, the mean RT for the group of subjects who used the Overlapped hand placement was 707 ms. This result is consistent with previous research that used the same four-choice precuing procedure in conjunction with the two different hand placements (Proctor & Reeve, 1988; Reeve & Proctor, 1984; Reeve et al. 1992).

The main effect of Precue showed that RTs attained using the precued conditions were faster overall when compared directly to the to the Uncued condition. More specifically, the Uncued presentation yielded a mean RT of 634 ms and the Hand-cued produced a mean RT of 585 ms. The Finger-cued precue revealed a mean RT of 610 ms while the Neither-cued stimulus configuration produced a mean RT of 625 ms. Customarily, the same pattern of RTs is obtained with the use of the four different precues (Proctor & Reeve, 1986, 1988; Proctor, Reeve, Weeks, Dornier & Van Zandt, 1991; Reeve & Proctor, 1984; Reeve et al, 1992).

The main effect of Interval produced mean RTs that typically became faster as the delay between the Precue Row and the Target Row increased. The mean RT for the 0 ms, 375 ms, 750 ms, 1500 ms, and 3000 ms SOA Interval was 732 ms, 599 ms, 607 ms, 575 ms, and 556 ms, respectively. Again, these results are consistent with previous research (Reeve & Proctor, 1984, Reeve et al, 1992).

The ANOVA identified three significant two-way interactions.

Specifically, Hand Placement x SOA Interval $F(4, 480) = 6.98$, $p<.001$, SOA Interval x Precue $F(12, 1440) = 149.0$, $p<.001$ and Hand Placement x Precue $F(3, 360) = 2.66$, $p<.05$.

The significant Hand Placement x SOA Interval interaction indicated that the slope for RT across the SOA Intervals was steeper for the Overlapped hand placement when compared against the slope of the Adjacent hand placement. The RT means using the Overlapped hand placement for the 0 ms, 375 ms, 750 ms, 1500 ms and 3000 ms SOA Intervals were 828 ms, 696 ms, 710, ms, 666 ms and 634 ms, respectively. In comparison, the RT means using the Adjacent hand placement for 0 ms, 375 ms, 750 ms, 1500 ms and 3000 ms SOA Intervals were 635 ms, 502 ms, 504 ms, 483 ms and 477 ms, respectively. This result suggests that the relative RT benefit is generally greater for the Overlapped hand placement as the interval between the Precue Row and the Target Row increases. This interaction is consistent with previous research (Reeve & Proctor, 1984).

The significant Interval x Precue Interaction shows that the RT benefit with the introduction of a meaningful precue generally increases as the interval between the Precue Row and Target Row increases. Moreover, when using a precue, the RTs observed tended to converge at longer SOA Intervals as compared with the Uncued condition (see Table 2). This is also a typical finding of the four-choice precuing procedure (Reeve & Proctor, 1984; Reeve et al., 1992).

The significant Hand Placement x Precue Interaction is also

consistent with previous work which used the same precuing procedure (Reeve & Proctor, 1984). The means for this interaction are presented in Table 3.

When comparing the two hand placements, different orderings for each precued condition occurred. For the Adjacent hand placement, the Hand-cued precue yielded the fastest RTs, the Finger-cued produced intermediate RTs and the Neither-cued turned out the slowest RTs. However, when the Overlapped hand placement was used in combination with the Hand-cued, it yielded the slowest RTs, the Finger-cued produced intermediate RTs and the Neither-cued precue yielded the fastest RTs. Thus, a reversal in the relative speed of responses was observed between the Hand-Cued and Neither-Cued precues with introduction of the Overlapped hand placement. With the Overlapped hand placement, the Hand-cued precue now stipulates the use of two different response fingers on different hands, whereas the Neither-cued precue now designates two different response fingers on the same hand. Therefore, the RT benefits associated with providing a precue is a direct result of the precue's spatial correspondence with the respective response location rather than simply the result of increasing the overall efficiency of responding by providing a precue that predicts a response will be required by one of two fingers on the same hand.

The analysis also revealed a significant Hand Placement x SOA Interval x Precue Interaction $F(12, 1440)$ $p, < .005$. This interaction reflects the greater differences observed in the precued conditions at shorter SOA Intervals when comparing the two

	Interval (ms)				
Precue	0	375	750	1500	3000
Uncued	709	612	635	599	613
Hand-cued	712	568	576	551	518
Finger-cued	753	591	596	559	542
Neither-cued	752	624	621	588	541

Table 2. - Mean Reaction Times for the Interaction of SOA Interval x Precue.

	Hand Placement	
Precue	Adjacent Hands	Overlapped Hands
Uncued	534	733
Hand-Cued	486	710
Finger-Cued	520	700
Neither-Cued	540	685

Table 3. - Mean Reaction Times for the Interaction of Hand Placement x Precue.

different hand placements (see Table 4).

Interestingly, the Hand Placement x Texture Organization x SOA Interval approached significance, $F(12, 480) = 1.58$, $p = .09$. This marginally significant interaction demonstrates the fact that for the standard Adjacent hand placement, the Control texture configurations were superior to all others, with RTs for all the Texture organizations converging at a SOA Interval of 3000 ms. However, for the Overlapped hand placement, there was a trend for the Left-Right texture placement condition to be superior to all others. In addition, there was no evidence demonstrating that RTs converged at the longest SOA Interval when the Overlapped hand placement was utilized (see Table 5).

Error Analysis. The error analysis revealed main effects of Precue, $F(3, 360) = 4.1$, $p<.01$, SOA Interval, $F(4, 480) = 33.2$, $p<.001$, and Hand Placement, $F(1, 120) = 32.9$, $p<.001$.

When the main effect of Precue is examined, it was noted a greater percentage of error (5.19%) occurred when using the Neither-cued precue. In comparison, the percentages of error for the Uncued, Hand-cued or Finger-cued precues was 4.03%, 4.01% and 4.53%, respectively. When examining the main effect of SOA Interval, the least amount of error (3.96%) occurred when subjects responded after a 1500 millisecond delay between the presentation of the Precue Row and the Target Row. In comparison, the percentage of error when using the 0 ms, 375 ms, 750 ms, and 3000 ms SOA Interval was observed to be 4.79%, 4.58%, 4.30%, and 4.56%, respectively. In addition, the analysis indicated that a

Hand Placements	Cues	Interval 0	375	750	1500	3000
Adjacent						
	Uncued	606	513	526	513	514
	Hand-cued	600	464	467	455	445
	Finger-cued	660	499	490	467	483
	Neither-cued	674	531	533	497	466
Overlapped						
	Uncued	811	711	744	686	712
	Hand-cued	825	673	685	648	592
	Finger-cued	847	683	702	653	617
	Neither-cued	830	717	710	679	616

Table 4. - Mean Reaction Times For The Interaction of Hand Placement x Precue x SOA Interval.

		Interval				
		0	375	750	1500	3000
Hand Placements						
Texture Organization						
Adjacent						
	Control	596	472	477	462	480
	Left-Right	622	506	511	491	478
	Inner-Outer	644	509	504	482	468
	Alternate	677	549	524	497	481
Overlapped						
	Control	816	698	718	665	640
	Left-Right	799	674	678	634	627
	Inner-Outer	842	681	718	657	606
	Alternate	855	731	728	708	663

Table 5. - Mean Reaction Times For The Interaction of Hand Placement x Texture Organization x SOA Interval.

significant increase in the percentage of error occurred when subjects used the Overlapped hand placement (PE = 6.06%) instead of the Adjacent hand placement (PE = 2.82%).

The Hand Placement x SOA Interval interaction also proved to be significant $F(4, 480)=7.7$, $p<.001$. This interaction represents a general decrease in error rates across the SOA Intervals for the Adjacent hand placement but not for the Overlapped hand placement (see Table 6). This result is consistent with the previous research (Reeve et al. 1992).

The Precue x SOA Interval Interaction was also significant $F(12, 1440)=3.3$, $p<.001$. This interaction is due to the percentage of error being moderate and generally increasing slightly across the SOA Intervals for the Uncued condition, whereas it began high and showed a trend to decrease slightly across intervals for the Hand-Cued, Finger-cued and Neither-Cued conditions (see Table 7).

Significant three-way interactions in the error analysis included Hand Placement x Texture Placement x Interval, $F(12, 480) = 1.9$, $p<.05$, and Hand Placement x Precue x Interval, $F(12, 1440)= 2.8$, $p<.001$. The former interaction reflects the fact that for the Adjacent hand placement, although there was a general decrease in error rates across SOA Intervals, the error rates were generally uniform for the different Texture Placements. However, for the Overlapped hand placement, error rates did not decrease as a function of SOA Interval. Moreover, error rates were higher for the Inner-Outer compared to the three other Texture Placements (see Table 8).

Hand Placements	Interval 0	375	750	1500	3000
Adjacent	3.83	2.68	2.98	1.91	2.66
Overlapped	5.74	6.47	5.62	6.01	6.45

Table 6. - Percentage of Error for The Interaction of Hand Placement x SOA Interval.

Cues	Interval 0	375	750	1500	3000
Uncued	3.32	3.71	3.80	4.40	4.88
Hand-Cued	4.10	4.25	3.66	3.37	4.64
Finger-Cued	5.81	5.08	4.25	3.76	3.71
Neither-Cued	5.91	5.27	5.47	4.30	4.98

Table 7. - Percentage of Error For The Interaction of Precue x SOA Interval.

The significant interaction of Hand Placement x Precue x SOA Interval indicates for the Adjacent hand placement, error rates were lowest for the Hand-cued condition, intermediate for the Finger-cued condition, and greatest for the Neither-cued condition, with all precued error rates showing a trend to converge at the longest SOA Interval. However, when the Overlapped hand placement was used, error rates were shown to be greatest when precued responses were executed using the same hand (now placed on alternating key locations), and least when they had neither finger nor hand identity in common (now placed on the two left-most keys or right-most keys), or when precued responses denoted finger identity (now placed on the two inner-most keys or two outer-most keys). Moreover, error rates when using the precued conditions did not show a general convergence at the longest SOA Interval (see Table 9).

Discussion

The manipulation of similarity grouping had little effect when it involved the Adjacent hands placement. Indeed, for that placement, RTs were generally faster for the Control organizations. However, for the Overlapped hands placement, there was a trend toward RTs being generally superior for the texture organization that grouped the left-right locations by similarity. Presumably, the salient left-right feature characteristic of the linear arrays is sufficiently salient for the Adjacent hands placement that it negates the influence of similarity grouping. However, because the Overlapped placement dissociates the effector and response

		SOA Interval				
		0	375	750	1500	3000
ADJACENT	CONTROL	4.785	3.028	2.930	1.856	3.418
	LEFT-RIGHT	4.394	2.637	2.246	1.953	2.637
	INNER-OUTER	3.320	2.442	3.320	1.758	1.856
	ALTERNATE	2.832	2.637	3.418	2.051	2.735
OVERLAPPED	CONTROL	5.469	6.153	5.957	6.740	6.738
	LEFT-RIGHT	5.176	5.273	4.102	5.791	6.055
	INNER-OUTER	6.152	9.178	7.324	6.641	8.008
	ALTERNATE	6.152	5.274	5.080	4.785	4.981

Table 8. - Percentage of Error for Significant Interaction of Hand Placement x Texture Placement x SOA Interval.

		SOA Interval				
		0	375	750	1500	3000
ADJACENT	UNCUED	2.735	2.930	3.125	2.149	3.321
	HAND-CUED	1.953	2.246	1.563	1.465	2.344
	FINGER-CUED	5.469	3.223	3.027	1.660	2.344
	NEITHER-CUED	5.176	2.344	4.199	2.344	2.637
OVERLAPPED	UNCUED	3.906	4.492	4.492	6.641	6.446
	HAND-CUED	6.249	6.250	5.762	5.273	6.933
	FINGER-CUED	6.152	6.934	5.470	5.860	5.078
	NEITHER-CUED	6.641	8.201	6.738	6.250	7.324

Table 9. - Percentage of Error for Significant Interaction of Hand Placement x Precue x SOA Interval.

locations, effector identity no longer compliments the coding of response location. Thus, for the Overlapped hands placement, responding tends to benefit from the emphasis brought about by similarity grouping of the left-right locations. This interpretation is consistent with the notion of hierarchial coding (Heister et al, 1990), in that the reduction of the left-right salience along the response dimension by overlapping the effectors, leads to greater reliance on the salience afforded by the similarity grouping.

General Discussion

For the four-choice spatial precuing task, a pattern of differential precuing benefits is typically obtained when pairs of responses from the middle and index fingers of the two hands are precued (Miller, 1982; Reeve & Proctor, 1984). Specifically RTs are superior when precued responses denote the two left-most or two right-most locations compared to alternate locations. The literature has converged on a response-translation account that explains the pattern in terms of processes that operate on the spatial codes that are used to represent the stimulus and response sets (Cauraugh, 1990; Cauraugh & Horrell, 1989; Proctor & Reeve, 1986, 1988). A variant of this account, referred to as the salient features coding principle (Proctor & Reeve, 1986), proposes that the translative processes occurring between the precue and cued subset is most efficient when the precue is consistent with the left-right feature of the stimulus-response ensemble.

Reeve et al. (1992) reasoned that if a pattern of differential precuing benefits is determined by relative salience, then the pattern should be influenced by manipulations that enhance the salience of other features of the stimulus-response ensemble. In three experiments, Reeve et al. actively manipulated the relative level of salience for the spatial features of the stimulus-response set in the four-choice spatial-precuing task, according to the Gestalt Laws of Grouping (e.g. Koffka, 1935/1963; Pomerantz & Kubovy, 1986). Consistent with the salient features coding principle, a systematic alteration of the pattern of precuing

benefits as a function of the pairings of elements made salient by the organizational manipulations was observed. Reeve et al. (1992) concluded that manipulations of stimulus set salience were relatively more effective than were the response set manipulations. However, Reeve et al. (1992) acknowledged that although the response set manipulations used in their study were relatively ineffective, other manipulations may prove to be more effective.

Taking this later conclusion as a starting point, the purpose of the present experiments was to assess further whether the organizational features of the response set could be manipulated to influence the coding operations of the translation stage in a manner consistent with the salient features coding principle. In Experiment 1, we used proximity grouping to examine the roles of absolute and relative spatial correspondence of the elements in the stimulus and response sets. A pattern of differential precuing benefits typical of the four-choice spatial precuing task was observed for both the Organized and Unorganized response arrangements when co-manipulated with the Together Display. The pattern of precuing benefits observed for the Separated Display was different from that observed for the Together Display. In sum, partitioning the stimulus set cancelled the precuing benefit for the inner-outer locations (Finger-cued condition) relative to the alternate locations (Neither-cued condition).

The manipulation of similarity grouping was examined in Experiment 2. For the Overlapped hands placement, performance tended to be superior for the texture organization condition that

grouped the left-right locations. Thus, for that hand placement, responding tends to benefit form the emphasis brought about by similarity grouping of the left-right locations. However, similarity grouping had little effect with the Adjacent hands placement.

Consistent with Reeve et al. (1992), the results of the present experiments indicate that the organizational correspondence between the S-R sets can influence the pattern of precuing benefits. The present studies extend those of Reeve et al. by confirming that manipulating the organization of the stimulus and response sets influences performance in a manner consistent with the perspective of the salient features coding. More importantly, the studies confirm the speculation by Reeve et al. that, although perhaps less robust than manipulations of the stimulus set, manipulating aspects of the response set other than spatial locations can also influence the mental codes assigned to the response set.

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APPENDICES

APPENDIX A

Consent Form

Instructions

INFORMED CONSENT
FOR
INFORMATION PROCESSING
LAKEHEAD UNIVERSITY
DEPARTMENT OF PHYSICAL EDUCATION

You are invited to participate in a study of human information processing which is being conducted by Dr. Dan Weeks. We are hoping to increase our knowledge about basic perceptual, cognitive, and motor skills.

If you decide to participate, each experimental session will last less than 30 minutes. There are no known or expected discomforts or risks involved in your participation. This judgement is based on a large body of experience with similar experimental tasks. Hopefully, the results of this experiment will aid us in understanding the nature of human cognition.

Any information obtained in connection with this study that can be identified with you will remain confidential. If in the event the study is to be published all information regarding the identity of subjects will remain confidential and anonymous. If you give us permission by signing this document we plan to publish the results in an appropriate psychological journal.

Your decision whether or not to participate will not prejudice your future relations with Lakehead University or the Physical Education Department. If you decide to participate, you are free to withdraw your consent and to discontinue participation at anytime without penalty. If you decide later to withdraw from the study, you may also withdraw any information which has been collected about you.

If you have any questions, we expect you to ask us. If you have additional questions later, Dr. Dan Weeks may be contacted at 343-8189. He will be happy to answer any inquiries that you may have.

YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNATURE INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED.

subject's signature	date	dominant hand

witness	investigators signature

subject's name (print)	age	sex

To begin a trial, a warning row of '+ + + +' will appear in the centre of the screen. The warning row corresponds with the "V", "B", "N", and "M" keys on the keyboard. Below the warning row a precue row will appear. The precue will designate possible target locations. The precue will be one of the following:

```
+ + + + (all targets possible)
or,   +   +
or,  +   +
or,  + +
or,     + +
or,  +     +
or,    + +
```

Following the precue row, a target stimulus will appear below one of the precued locations. You should press the appropriate key corresponding to the target location as quickly and accurately as possible.

For example:

```
(warning row)  + + + +
(precue row)   + +
(target)       +
```

In this instance the correct response would have been to press the "V" key. On all trials, try to use the information provided by the precue to help you respond (the precues are always valid). REMEMBER, YOUR TASK IS TO RESPOND QUICKLY AND ACCURATELY TO THE STIMULUS. IF YOU HAVE ANY QUESTIONS, ASK YOUR EXPERIMENTER NOW.

APPENDIX B

Reaction Time Analysis - Experiment 1

Reaction Time Cell Means - Experiment 1

Percentage Error Analysis - Experiment 1

Percentage Error Cell Means - Experiment 1

Reaction Time Analysis - Experiment 1

Main Effects

	SS	MS	df	f	p
RESPONSE ORGANIZATION	54249.13	54249.13	1	.250	-
error	6505498.25	216849.94	30		
DISPLAY ORGANIZATION	116338.50	116338.50	1	1.844	.181
error	1892732.06	63091.07	30		
PRECUE CONDITION	746002.25	248667.42	3	76.22	<.001
error	293629.56	3262.55	90		
INTERVAL	3149678.00	787419.50	4	87.07	<.001
error	1085288.63	9044.07	120		

Two-Way Interactions

	SS	MS	df	f	p
RESPONSE ORGANIZATION x DISPLAY ORGANIZATION	13139.13	13139.13	1	.208	-
error	1892732.06	63091.07	30		
RESPONSE ORGANIZATION x PRECUE	14999.38	4999.79	3	1.532	.210
error	293629.56	3262.55	90		
RESPONSE ORGANIZATION x INTERVAL	11163.38	2790.84	4	.309	-
error	1085288.63	9044.07	120		
DISPLAY ORGANIZATION x PRECUE	36331.00	12110.33	3	5.054	.003
error	215674.88	2396.39	90		
DISPLAY ORGANIZATION x INTERVAL	6341.38	1585.34	4	.524	-
error	363107.69	3025.90	120		
PRECUE x INTERVAL	227009.50	18917.46	12	12.148	<.001
error	560609.19	1557.25	360		

Three-way Interactions

	SS	MS	df	f	p
RESPONSE ORGANIZATION x DISPLAY ORGANIZATION x INTERVAL	1134.50	283.63	4	.094	-
error	363107.69	3025.90	120		
RESPONSE ORGANIZATION x PRECUE x INTERVAL	25068.00	2089.00	12	1.341	.192
error	560609.188	1557.25	360		
DISPLAY ORGANIZATION x PRECUE x INTERVAL	34858.63	2904.89	12	1.887	.034
error	554122.50	1539.23	360		
RESPONSE ORGANIZATION x DISPLAY ORGANIZATION x PRECUE	1204.63	401.54	3	.168	-
error	215674.88	2396.39	90		

Four-Way Interaction

	SS	MS	df	f	p
RESPONSE ORGANIZATION x DISPLAY ORGANIZATION x PRECUE x INTERVAL	10172.88	847.74	12	.551	-
error	554122.50	1539.23	360		

Reaction Time Cell Means - Experiment 1

DISPLAY SEPARATED

	UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
		7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
		5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
				0	0				0	0				0	0				0	0
* Unorganized Response Set - all keys textured																				
s1	649	575	575	535	513	655	552	534	467	446	808	739	579	476	518	669	671	665	533	535
s2	542	472	458	495	460	479	428	417	428	396	543	466	497	430	374	555	477	435	404	378
s3	551	457	423	450	421	568	408	471	428	398	600	346	462	425	398	613	411	509	490	461
s4	509	475	505	514	490	511	394	425	416	440	557	494	487	540	487	566	495	466	490	459
s5	607	613	567	578	606	580	597	469	471	485	669	649	638	571	508	625	566	640	660	522
s6	648	530	471	538	616	589	464	449	426	436	696	623	501	561	484	751	653	517	492	436
s7	596	501	521	532	476	564	510	425	477	414	615	557	506	417	441	617	504	506	443	416
s8	797	651	468	516	447	632	364	559	430	423	695	400	523	564	429	895	424	593	483	493
* Unorganized Response Set - no keys textured																				
s9	589	478	495	477	443	564	429	425	382	343	606	489	448	442	384	610	488	449	469	377
s10	719	631	612	600	614	695	561	495	603	645	749	711	645	685	642	741	596	672	629	670
s11	621	523	552	563	528	575	475	452	500	464	811	680	650	582	557	706	606	597	573	512
s12	718	503	474	490	497	608	441	476	462	425	688	563	551	498	476	647	541	570	526	471
s13	623	528	559	512	589	568	452	421	452	479	653	598	519	548	494	600	559	550	502	552
s14	665	501	556	558	560	567	435	413	440	466	643	536	474	408	502	783	535	527	534	519
s15	552	477	484	533	511	499	403	438	480	451	609	535	525	579	545	579	489	517	640	571
s16	557	618	591	573	547	568	530	544	485	480	710	656	639	659	568	742	576	904	611	557
* Organized Response Set - two left-most keys textured																				
s17	995	1020	751	815	830	855	769	863	772	800	1038	976	876	801	862	916	760	830	906	770
s18	522	492	528	494	490	539	437	430	391	432	701	538	508	401	415	640	550	483	428	412
s19	646	531	571	532	540	615	450	462	464	456	631	528	529	488	500	647	588	589	523	484
s20	476	395	371	389	369	466	360	373	304	289	492	425	406	332	343	460	444	472	347	349
s21	611	361	392	398	373	472	345	366	352	349	566	344	342	360	318	503	454	348	325	291
s22	678	553	593	575	540	611	471	462	429	414	715	562	566	510	460	783	620	614	596	533
s23	451	413	448	424	472	429	385	403	390	420	473	414	445	447	400	464	407	446	396	411
s24	599	496	474	496	480	521	442	457	400	439	689	551	463	425	433	573	528	520	442	428
* Organized Response Set - two right-most keys textured																				
s25	570	463	481	491	497	543	426	424	399	415	665	531	495	539	460	595	531	527	477	480
s26	630	602	586	572	561	637	522	558	567	470	761	603	619	570	550	691	574	643	585	555
s27	624	475	511	529	477	593	427	442	416	478	649	547	522	499	468	672	494	509	591	451
s28	621	446	465	461	519	554	452	414	461	418	564	443	479	484	535	595	477	550	511	491
s29	536	465	458	522	444	479	391	425	431	422	525	471	422	484	438	523	532	459	499	463
s30	485	514	532	456	482	487	476	502	490	446	516	528	520	505	484	521	560	518	506	550
s31	634	576	537	589	508	597	507	426	429	439	689	623	471	437	439	689	627	509	449	490
s32	563	526	535	439	522	513	425	427	399	437	580	495	517	445	461	575	573	470	440	439

Reaction Time Cell Means - Experiment 1

DISPLAY TOGETHER

	UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
		7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
		5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
				0	0				0	0				0	0				0	0
* Unorganized Response Set - all keys textured																				
s1	602	426	484	450	445	557	448	391	411	371	612	562	503	448	414	628	529	516	406	425
s2	454	436	436	420	428	435	409	383	398	386	437	382	388	411	369	421	394	403	371	358
s3	526	453	458	469	400	456	386	398	374	417	546	425	411	420	409	549	399	446	427	392
s4	428	412	438	466	480	468	405	402	417	439	518	430	485	449	452	488	454	450	421	459
s5	704	672	593	691	633	763	603	479	535	433	747	724	672	564	478	782	735	698	563	573
s6	601	575	486	530	530	634	534	507	416	447	678	495	467	396	476	760	503	548	435	451
s7	647	509	556	578	502	599	462	495	457	425	632	566	547	446	507	731	565	531	485	513
s8	836	374	513	477	564	879	255	498	460	406	808	489	702	573	424	897	563	597	748	439
* Unorganized Response Set - no keys textured																				
s9	517	423	467	449	435	483	392	383	355	347	541	420	415	380	359	565	427	438	388	367
s10	565	507	511	485	531	541	460	499	486	498	600	601	504	470	485	580	499	496	576	459
s11	611	629	509	575	541	571	448	515	523	502	603	560	505	505	465	587	561	560	563	520
s12	523	384	438	459	412	482	384	390	379	366	517	421	474	418	361	527	500	446	413	391
s13	655	551	551	494	514	563	492	499	472	444	683	529	524	491	441	702	548	512	548	504
s14	604	528	527	537	534	582	435	424	471	408	620	471	447	434	468	703	498	530	524	420
s15	613	456	495	519	532	527	448	479	427	537	600	467	522	547	516	711	486	512	578	497
s16	649	591	624	604	599	749	574	625	626	537	765	632	714	645	514	809	643	671	607	672
* Organized Response Set - two left-most keys textured																				
s17	631	537	653	546	597	707	509	515	588	561	732	559	708	538	571	689	700	704	617	706
s18	412	412	430	436	403	468	361	352	325	316	450	373	313	316	289	474	378	363	326	319
s19	486	458	509	434	613	508	427	407	478	443	612	444	425	422	375	561	512	441	392	438
s20	407	354	361	370	292	384	320	304	293	299	369	320	283	263	265	407	340	338	283	273
s21	472	421	333	361	403	521	458	374	359	337	495	346	347	363	301	495	375	377	345	311
s22	679	579	563	651	601	684	596	572	587	426	733	705	650	490	517	763	742	571	589	624
s23	528	457	463	501	464	496	440	440	411	412	534	434	453	450	427	578	453	508	464	409
s24	647	575	554	573	474	610	461	518	405	441	650	465	533	447	432	623	556	509	448	458
* Organized Response Set - two right-most keys textured																				
s25	570	479	615	467	495	613	420	498	464	440	620	432	637	485	533	562	469	485	496	536
s26	509	475	455	475	493	518	407	404	399	380	531	466	466	475	404	522	445	445	405	355
s27	619	481	514	576	536	558	401	423	528	390	617	467	556	493	543	622	450	474	453	424
s28	506	450	487	464	510	449	387	427	413	393	603	478	453	430	416	510	438	442	467	446
s29	768	640	625	637	545	734	544	504	524	517	712	619	577	613	539	879	604	613	579	512
s30	478	500	498	612	525	476	490	490	487	572	513	513	489	503	501	514	522	490	489	490
s31	755	680	650	613	534	822	633	518	448	476	1070	718	628	461	435	1123	826	656	604	464
s32	623	510	545	684	596	642	522	458	419	425	787	547	556	481	474	804	657	613	636	482

Percentage Error Analysis - Experiment 1

Main Effects

	SS	MS	df	f	p
RESPONSE ORGANIZATION	18.050	18.050	1	.532	-
error	1018.250	33.942	30		
DISPLAY ORGANIZATION	20.000	20.000	1	5.800	.021
error	103.450	3.448	30		
PRECUE	33.231	11.077	3	16.242	<.001
error	61.36	.682	90		
INTERVAL	78.156	19.539	4	4.139	.003
error	566.516	4.721	120		

Two-Way Interactions

	SS	MS	df	f	p
RESPONSE ORGANIZATION X DISPLAY ORGANIZATION	9.800	9.800	1	2.842	.098
error	103.450	3.448	30		
RESPONSE ORGANIZATION X PRECUE	2.856	.952	3	1.396	.248
error	61.363	.682	90		
RESPONSE ORGANIZATION X INTERVAL	22.028	5.507	4	1.166	.328
error	566.516	4.721	120		
DISPLAY ORGANIZATION X PRECUE	7.356	2.452	3	2.061	.109
error	107.062	1.190	90		
DISPLAY ORGANIZATION X INTERVAL	5.719	1.430	4	1.329	.262
error	129.097	1.076	120		
PRECUE X INTERVAL	22.028	5.507	12	1.166	.328
error	566.516	4.721	360		

Three-Way Interactions

	SS	MS	df	f	p
RESPONSE ORGANIZATION X PRECUE X INTERVAL	9.253	.771	12	1.071	.383
error	259.247	.720	360		
DISPLAY ORGANIZATION X PRECUE X INTERVAL	9.113	.759	12	1.515	.116
error	180.266	.501	360		
RESPONSE ORGANIZATION X DISPLAY ORGANIZATION X PRECUE	.531	.177	3	.149	
error	107.062	1.190	90		
RESPONSE ORGANIZATION X DISPLAY ORGANIZATION X INTERVAL	5.684	1.421	4	1.321	.265
error	129.097	1.076	120		

Four-Way Interaction

	SS	MS	df	f	p
RESPONSE ORGANIZATION X DISPLAY ORGANIZATION X PRECUE X INTERVAL	5.922	.493	12	.984	-
error	180.266	.501	360		

Percentage Error Cell Means - Experiment 1

DISPLAY SEPARATED

	UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300
* Unorganized Response Set - all keys textured																				
s1	12.50	00.00	12.50	00.00	12.50	00.00	06.25	06.25	25.00	00.00	06.25	18.75	06.25	12.50	00.00	12.50	06.25	00.00	18.75	06.25
s2	12.50	12.50	12.50	25.00	00.00	18.75	06.25	06.25	12.50	18.75	06.25	12.50	18.75	06.25	00.00	18.75	12.50	00.00	06.25	06.25
s3	62.50	37.50	25.00	00.00	12.50	25.00	37.50	06.25	06.25	12.50	56.25	25.00	18.75	18.75	00.00	25.00	37.50	12.50	00.00	00.00
s4	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	18.75	06.25	12.50	00.00	00.00	00.00	00.00
s5	00.00	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s6	00.00	12.50	25.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s7	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	12.50	00.00	00.00	00.00	00.00
s8	75.00	50.00	62.50	12.50	12.50	62.50	62.50	25.00	00.00	12.50	56.25	43.75	12.50	06.25	00.00	50.00	50.00	31.25	06.25	00.00
* Unorganized Response Set - no keys textured																				
s9	12.50	12.50	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	12.50	06.25	12.50	00.00	00.00	06.25
s10	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	18.75	00.00
s11	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	06.25	06.25	00.00	06.25	00.00	00.00	00.00
s12	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	25.00	12.50	00.00	12.50	00.00	06.25	06.25	00.00	06.25	12.50
s13	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	00.00	00.00	00.00	06.25
s14	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s15	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	12.50	12.50	00.00	00.00	18.75	12.50
s16	00.00	00.00	25.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	12.50	18.75	00.00	00.00	06.25
* Organized Response Set - two left-most keys textured																				
s17	00.00	00.00	25.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00
s18	00.00	00.00	00.00	12.50	25.00	00.00	00.00	00.00	00.00	06.25	12.50	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s19	12.50	00.00	00.00	12.50	12.50	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	12.50	00.00
s20	12.50	12.50	62.50	50.00	25.00	06.25	06.25	00.00	12.50	00.00	25.00	06.25	06.25	06.25	00.00	25.00	06.25	06.25	12.50	06.25
s21	00.00	12.50	00.00	12.50	25.00	06.25	12.50	18.75	12.50	00.00	12.50	12.50	00.00	00.00	06.25	12.50	18.75	06.25	00.00	00.00
s22	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00
s23	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	06.25	00.00	06.25	00.00	00.00	00.00
s24	00.00	12.50	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	12.50	06.25	06.25	00.00	00.00	06.25	06.25	00.00	06.25	00.00
* Organized Response Set - two right-most keys textured																				
s25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	12.50	00.00	00.00	06.25	00.00	18.75	12.50	18.75	00.00	00.00
s26	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25
s27	00.00	25.00	12.50	12.50	25.00	00.00	00.00	00.00	00.00	06.25	06.25	31.25	12.50	06.25	00.00	12.50	31.25	06.25	37.50	06.25
s28	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	25.00
s29	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s30	00.00	12.50	12.50	00.00	12.50	00.00	00.00	00.00	00.00	00.00	18.75	00.00	06.25	00.00	06.25	25.00	00.00	00.00	12.50	18.75
s31	00.00	00.00	12.50	12.50	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s32	00.00	00.00	00.00	12.50	12.50	00.00	06.25	06.25	06.25	00.00	12.50	12.50	00.00	06.25	06.25	12.50	00.00	00.00	06.25	06.25

Percentage Error Cell Means - Experiment 1

DISPLAY TOGETHER

	UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
		7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
		5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
				0	0				0	0				0	0				0	0

* Unorganized Response Set - all keys textured

s1	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00
s2	00.00	25.00	00.00	00.00	12.50	06.25	06.25	00.00	00.00	06.25	18.75	18.75	00.00	06.25	06.25	25.00	12.50	06.25	06.25	06.25
s3	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	06.25	06.25	00.00	00.00	00.00	06.25	06.25	00.00	00.00
s4	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	06.25	06.25	06.25	06.25	00.00	00.00	00.00	00.00	00.00	06.25
s5	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	06.25	06.25
s6	00.00	00.00	00.00	00.00	00.00	12.50	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	06.25	00.00	00.00	00.00	00.00
s7	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	06.25	12.50	06.25	00.00	00.00	06.25
s8	62.50	50.00	37.50	00.00	00.00	43.75	81.25	12.50	00.00	06.25	43.75	56.25	25.00	12.50	25.00	43.75	37.50	43.75	00.00	06.25

* Unorganized Response Set - no keys textured

s9	00.00	00.00	25.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	12.50	00.00	06.25	00.00	06.25
s10	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s11	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s12	00.00	12.50	12.50	00.00	12.50	00.00	00.00	06.25	00.00	06.25	06.25	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00
s13	12.50	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s14	00.00	12.50	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s15	00.00	00.00	00.00	00.00	12.50	06.25	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	12.50	00.00	00.00	12.50	00.00
s16	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	12.50	00.00	00.00	12.50	00.00	00.00

* Organized Response Set - two left-most keys textured

s17	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s18	00.00	00.00	00.00	00.00	12.50	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s19	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	06.25	00.00	00.00	06.25	00.00	00.00	06.25	00.00	00.00
s20	12.50	12.50	00.00	12.50	00.00	12.50	12.50	12.50	00.00	00.00	31.25	06.25	06.25	00.00	06.25	18.75	12.50	06.25	00.00	06.25
s21	00.00	00.00	25.00	00.00	12.50	12.50	06.25	06.25	00.00	25.00	12.50	06.25	12.50	00.00	00.00	25.00	18.75	06.25	06.25	00.00
s22	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	06.25	06.25	12.50	06.25	06.25
s23	00.00	00.00	00.00	00.00	12.50	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	06.25	12.50	00.00
s24	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	06.25	06.25	00.00	00.00	00.00	00.00	06.25	12.50	06.25

* Organized Response Set - two right-most keys textured

s25	00.00	00.00	12.50	00.00	12.50	06.25	06.25	00.00	12.50	06.25	12.50	12.50	06.25	00.00	06.25	18.75	12.50	06.25	06.25	06.25
s26	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25
s27	00.00	00.00	00.00	00.00	00.00	25.00	00.00	00.00	00.00	00.00	06.25	12.50	12.50	00.00	12.50	00.00	06.25	12.50	06.25	00.00
s28	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	18.75	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s29	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	12.50	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00
s30	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	06.25	00.00	12.50	12.50	00.00	00.00	06.25	06.25
s31	00.00	00.00	00.00	12.50	00.00	12.50	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	12.50	06.25	00.00	00.00	00.00
s32	00.00	12.50	00.00	12.50	00.00	06.25	06.25	00.00	00.00	00.00	12.50	06.25	00.00	06.25	12.50	06.25	00.00	00.00	06.25	12.50

APPENDIX C

Reaction Time Cell Means - Experiment 2

Reaction Time Analysis - Experiment 2

Percentage Error Cell Means - Experiment 2

Percentage Error Analysis - Experiment 2

Reaction Time Cell Means - Experiment 2

ADJACENT HAND PLACEMENT

UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
	7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
	5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
			0	0				0	0				0	0				0	0

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* Control - all keys textured

s001 1042 0742 0627 0673 0686 0882 0598 0637 0568 0603 0801 0664 0684 0733 0670 0944 0674 0784 0658 0577
s002 0551 0495 0568 0511 0536 0590 0476 0478 0491 0510 0597 0528 0548 0490 0517 0682 0492 0502 0562 0499
s003 0443 0371 0367 0371 0351 0434 0308 0327 0307 0317 0432 0309 0335 0322 0318 0431 0350 0325 0312 0306
s004 0564 0486 0594 0520 0475 0528 0414 0432 0430 0387 0647 0454 0453 0399 0426 0661 0498 0488 0437 0432
s005 0489 0448 0444 0482 0483 0497 0399 0381 0378 0413 0517 0388 0398 0366 0369 0511 0451 0435 0368 0368
s006 0500 0417 0476 0451 0477 0494 0383 0427 0434 0411 0529 0418 0426 0456 0429 0516 0440 0450 0425 0403
s007 0584 0575 0494 0529 0444 0570 0488 0454 0464 0475 0657 0572 0574 0552 0564 0634 0543 0560 0520 0557
s008 0623 0535 0620 0495 0540 0744 0527 0521 0502 0543 0815 0532 0546 0606 0530 0873 0599 0578 0585 0530

* Control - no keys textured

s009 0449 0361 0381 0348 0367 0445 0374 0346 0330 0287 0483 0341 0321 0318 0298 0456 0353 0368 0301 0309
s010 0551 0463 0469 0473 0483 0551 0462 0453 0427 0376 0605 0425 0443 0380 0361 0527 0495 0445 0414 0361
s011 0522 0463 0514 0457 0508 0512 0433 0362 0403 0385 0546 0440 0373 0421 0393 0626 0445 0395 0410 0361
s012 0470 0476 0421 0439 0527 0514 0419 0422 0399 0394 0538 0416 0415 0365 1927 0587 0501 0450 0412 0407
s013 0624 0513 0603 0558 0535 0664 0522 0547 0573 0629 0765 0564 0584 0575 0545 0667 0554 0564 0606 0580
s014 0634 0468 0510 0553 0499 0611 0479 0458 0422 0464 0709 0566 0520 0488 0489 0666 0542 0531 0484 0492
s015 0569 0466 0460 0486 0460 0614 0416 0445 0395 0435 0607 0430 0446 0409 0387 0677 0479 0464 0432 0452
s016 0565 0462 0546 0477 0473 0534 0372 0479 0447 0454 0564 0474 0457 0492 0502 0530 0469 0417 0477 0466

* Left-Right - two right-most keys textured

s017 0500 0371 0472 0462 0358 0432 0432 0380 0383 0381 0510 0373 0417 0348 0351 0450 0400 0398 0394 0386
s018 0621 0461 0519 0540 0478 0580 0453 0463 0447 0402 0576 0473 0530 0443 0395 0677 0620 0526 0492 0422
s019 0612 0619 0602 0671 0583 0605 0521 0491 0579 0508 0799 0624 0535 0471 0581 0773 0649 0669 0650 0568
s020 0644 0532 0507 0503 0496 0582 0439 0456 0369 0427 0671 0511 0456 0374 0427 0745 0592 0587 0436 0386
s021 0582 0568 0546 0537 0494 0618 0472 0496 0436 0445 0624 0485 0496 0430 0460 0626 0513 0466 0462 0488
s022 0484 0428 0450 0520 0470 0493 0417 0432 0473 0486 0519 0407 0483 0444 0460 0514 0445 0487 0457 0420
s023 0451 0452 0461 0442 0460 0471 0442 0430 0474 0431 0544 0479 0445 0439 0479 0533 0467 0444 0438 0447
s024 0678 0539 0605 0531 0571 0596 0464 0441 0496 0485 0684 0439 0525 0505 0569 0606 0468 0490 0571 0570

* Left-Right - two left-most keys textured

s025 0720 0625 0703 0651 0563 0886 0682 0586 0547 0524 0826 0656 0664 0559 0618 0961 0747 0968 0640 0594
s026 0598 0410 0479 0439 0454 0545 0430 0435 0378 0417 0630 0453 0384 0417 0392 0596 0519 0495 0422 0372
s027 0565 0473 0489 0459 0531 0508 0403 0399 0366 0350 0597 0472 0432 0397 0376 0641 0606 0476 0365 0350
s028 0631 0671 0634 0638 0714 0720 0501 0546 0574 0535 0842 0617 0501 0537 0527 0843 0608 0646 0732 0565
s029 0671 0435 0536 0538 0502 0600 0528 0492 0423 0529 0687 0508 0528 0403 0513 0738 0556 0535 0453 0391
s030 0637 0547 0525 0552 0576 0675 0480 0474 0519 0471 0750 0538 0599 0559 0529 0725 0625 0649 0652 0588
s031 0510 0443 0402 0512 0425 0481 0422 0407 0383 0395 0511 0447 0420 0406 0408 0489 0427 0405 0457 0400
s032 0581 0498 0581 0541 0550 0576 0463 0489 0597 0492 0595 0521 0565 0560 0498 0691 0539 0545 0550 0581

Reaction Time Cell Means - Experiment 2

ADJACENT HAND PLACEMENT

UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
	7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
	5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
			0	0				0	0				0	0				0	0

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* Inner-Outer - two outer-most keys textured

s033 0532 0623 0516 0649 0493 0593 0476 0492 0473 0450 0672 0595 0556 0474 0441 0684 0695 0607 0535 0552
s034 0457 0404 0406 0462 0442 0430 0364 0371 0364 0319 0592 0371 0366 0384 0345 0535 0441 0405 0377 0353
s035 0701 0640 0570 0666 0580 0737 0453 0573 0590 0497 0703 0501 0572 0614 0488 0793 0597 0618 0602 0538
s036 0785 0614 0627 0558 0605 0704 0520 0508 0492 0546 0991 0557 0540 0470 0478 0845 0623 0550 0512 0466
s037 0997 0724 0641 0617 0676 0889 0704 0800 0690 0678 1044 0860 0761 0727 0693 1016 0870 0905 0847 0770
s038 0804 0626 0673 0699 0668 0730 0624 0541 0543 0490 0841 0912 0663 0716 0625 1039 0703 0831 0697 0729
s039 0558 0470 0473 0442 0435 0539 0408 0402 0397 0414 0599 0470 0386 0387 0380 0563 0500 0519 0434 0389
s040 0661 0502 0440 0400 0496 0568 0403 0434 0348 0404 0595 0389 0371 0365 0340 0682 0458 0464 0386 0358

* Inner-Outer - two inner-most keys textured

s041 0664 0457 0502 0478 0483 0560 0435 0492 0478 0453 0681 0456 0478 0470 0470 0611 0497 0497 0489 0457
s042 0771 0665 0679 0610 0585 0593 0453 0446 0528 0430 0659 0638 0476 0511 0496 0684 0507 0487 0541 0487
s043 0590 0466 0482 0461 0543 0567 0493 0479 0433 0406 0631 0498 0505 0429 0346 0602 0572 0560 0416 0430
s044 0507 0362 0378 0343 0373 0467 0359 0337 0305 0301 0485 0354 0340 0321 0312 0511 0362 0334 0327 0290
s045 0563 0500 0543 0463 0574 0530 0431 0474 0473 0454 0575 0400 0467 0523 0434 0625 0419 0544 0466 0436
s046 0517 0445 0442 0419 0468 0496 0439 0388 0377 0372 0518 0508 0399 0383 0361 0572 0498 0424 0384 0387
s047 0512 0401 0457 0448 0432 0557 0387 0393 0414 0413 0558 0411 0401 0397 0505 0603 0429 0518 0440 0420
s048 0477 0467 0535 0414 0463 0536 0395 0431 0411 0408 0578 0384 0369 0388 0367 0564 0400 0435 0407 0440

* Alternate - b & n keys textured

s049 0566 0563 0414 0432 0440 0559 0403 0418 0352 0345 0633 0460 0403 0334 0322 0579 0457 0501 0414 0358
s050 0748 0681 0776 0656 0608 0845 0657 0611 0631 0525 0959 0654 0656 0642 0616 0925 0727 0696 0736 0658
s051 0504 0395 0439 0460 0457 0595 0427 0439 0381 0383 0541 0396 0390 0384 0396 0662 0458 0428 0423 0445
s052 0637 0463 0520 0488 0479 0577 0442 0438 0413 0417 0650 0469 0454 0391 0365 0643 0479 0500 0383 0425
s053 0736 0658 0549 0670 0574 0738 0496 0530 0474 0499 1078 0552 0683 0531 0536 0978 0621 0655 0669 0478
s054 0610 0569 0535 0481 0453 0618 0455 0425 0386 0400 0747 0483 0427 0425 0579 0722 0560 0563 0444 0382
s055 0601 0439 0474 0427 0485 0523 0436 0395 0411 0387 0553 0448 0475 0410 0424 0619 0464 0433 0503 0483
s056 0588 0496 0503 0485 0596 0639 0471 0474 0422 0459 0638 0413 0436 0473 0389 0680 0536 0591 0478 0429

* Alternate - v & n keys textured

s057 0676 0619 0566 0579 0625 0683 0510 0537 0501 0490 0708 0595 0581 0537 0507 0815 0636 0668 0621 0564
s058 0589 0442 0590 0474 0650 0553 0467 0477 0478 0477 0556 0454 0506 0524 0503 0683 0462 0598 0509 0490
s059 0658 0534 0587 0520 0548 0727 0526 0523 0587 0419 0727 0579 0598 0446 0412 0734 0585 0524 0449 0403
s060 0671 0563 0587 0589 0560 0703 0541 0576 0521 0523 0829 0629 0549 0545 0473 0662 0563 0604 0579 0590
s061 0728 0773 0697 0714 0572 0881 0560 0561 0557 0513 0830 0617 0704 0701 0605 0760 0652 0671 0663 0609
s062 0606 0588 0528 0519 0534 0646 0484 0546 0445 0504 0662 0470 0524 0535 0607 0989 0587 0515 0573 0476
s063 0508 0447 0426 0400 0395 0495 0386 0366 0392 0349 0547 0394 0381 0363 0349 0548 0438 0470 0454 0367
s064 0626 0449 0483 0452 0539 0594 0449 0453 0436 0405 0658 0499 0467 0452 0410 0611 0500 0450 0485 0552

Reaction Time Cell Means - Experiment 2

OVERLAPPED HAND PLACEMENT

UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
	7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
	5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
			0	0				0	0				0	0				0	0

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* Control - all keys textured

s065 0833 0817 1014 0845 0881 0873 0868 0742 0780 0589 0982 0894 0902 0591 0923 0959 0850 0858 0833 0710
s066 0706 0629 0717 0602 0714 0747 0568 0690 0644 0655 0762 0772 0650 0636 0533 0748 0647 0676 0726 0656
s067 0699 0816 0886 0586 0701 0745 0625 0617 0604 0644 0807 0599 0617 0624 0626 0701 0576 0556 0719 0546
s068 1242 0851 0956 0627 1209 0970 0945 0829 0916 0804 0998 1106 1026 1028 0879 0950 0786 0879 1023 0846
s069 0755 0582 0664 0582 0701 0801 0656 0661 0491 0460 0876 0633 0575 0495 0382 0683 0551 0672 0505 0475
s070 0570 0583 0666 0703 0641 0750 0642 0551 0764 0522 0852 0545 0662 0668 0536 0703 0677 0645 0612 0670
s071 0998 0715 0571 0546 0644 0814 0756 0692 0610 0582 0885 0783 0755 0652 0624 1074 0729 0672 0849 0676
s072 0789 0864 0710 0761 0560 0964 0682 0713 0537 0469 0985 0704 0619 0595 0446 0884 0735 0793 0658 0503

* Control - no keys textured

s073 0789 0616 0599 0674 0851 0714 0692 0696 0583 0599 0791 0600 0759 0633 0533 0748 0819 0651 0607 0556
s074 0630 0697 0763 0507 0836 0690 0750 0676 0574 0576 0760 0718 0619 0550 0652 0732 0571 0639 0617 0742
s075 0651 0504 0585 0648 0487 0800 0627 0767 0525 0550 0768 0615 0578 0453 0481 0718 0687 0735 0575 0590
s076 0648 0858 0607 0590 0583 0913 0685 0585 0593 0492 0772 0419 0562 0483 0391 0675 0659 0702 0742 0619
s077 0726 0605 0658 0575 0660 0729 0561 0592 0543 0617 0757 0582 0664 0625 0516 0690 0610 0559 0600 0625
s078 0791 1020 0939 0834 0734 0928 0682 0776 0754 0617 1048 0677 0774 0836 0677 1143 0834 0950 0574 0761
s079 0841 0857 1033 0873 0828 0863 0767 1101 1380 0809 1036 0744 0868 0753 0853 0956 0650 0954 0929 0686
s080 0681 0612 0613 0527 0560 0685 0466 0545 0508 0649 0765 0646 0524 0536 0507 0691 0640 0639 0586 0529

* Left-Right - two right-most keys textured

s081 0521 0471 0654 0574 0667 0596 0482 0530 0453 0563 0548 0527 0547 0501 0507 0663 0558 0556 0465 0471
s082 0939 1088 0755 0786 0798 0917 0812 0907 0668 0622 1040 0816 0882 0625 0578 0971 0838 0828 0675 0543
s083 0594 0527 0531 0523 0470 0643 0480 0470 0460 0435 0651 0526 0638 0413 0503 0622 0504 0499 0493 0421
s084 0885 0638 0652 0828 0519 0744 0799 0765 0661 0666 0798 0737 0751 0693 0587 1002 0898 0869 0835 1031
s085 0808 0803 0761 0615 0832 0709 0538 0588 0692 0615 0700 0681 0761 0720 0660 0747 0626 0687 0673 0583
s086 0729 0523 0702 0536 0700 0696 0572 0517 0458 0485 0639 0539 0591 0541 0571 0751 0599 0672 0594 0522
s087 0903 0796 0747 0660 0766 0803 0633 0635 0617 0635 0748 0615 0668 0617 0580 0784 0720 0703 0694 0568
s088 0825 0688 0835 0721 0900 0963 0640 0559 0577 0487 1136 0617 0838 0642 0778 0918 0816 0854 1087 0657

* Left-Right - two left-most keys textured

s089 0979 0770 0729 0624 0970 0907 0744 0686 0679 0772 0957 0683 0689 0700 0693 0832 0853 0722 0724 0655
s090 0780 0718 0603 0595 0637 0749 0575 0493 0551 0632 0822 0600 0637 0513 0540 0627 0629 0691 0654 0573
s091 0935 0762 0893 0869 0675 1048 0793 0840 0667 0659 0973 0751 0785 0706 0770 0940 0749 0753 0692 0738
s092 0724 0580 0666 0633 0671 0778 0688 0587 0673 0540 0779 0693 0560 0634 0640 0727 0704 0628 0633 0647
s093 0749 0898 0822 0660 0809 0912 0658 0572 0622 0512 0771 0607 0609 0614 0640 0808 0634 0577 0680 0632
s094 0655 0737 0698 0700 0661 0897 0675 0645 0645 0504 0708 0666 0645 0554 0615 0895 0687 0753 0704 0566
s095 0932 0805 0709 0902 0602 0993 0629 0805 0608 0604 0778 0738 0632 0661 0615 0841 0712 0692 0575 0678
s096 0697 0574 0586 0530 0733 0563 0619 0525 0474 0486 0718 0566 0501 0468 0467 0660 0541 0706 0551 0498

Reaction Time Cell Means - Experiment 2

OVERLAPPED HAND PLACEMENT

UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
	7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
	5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
			0	0				0	0				0	0				0	0

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* Inner-Outer - two outer-most keys textured

s097	0991	0788	0964	0736	0694	0840	0648	0829	0725	0574	0932	0755	0785	0722	0696	0896	0755	0716	0787	0691
s098	0740	0701	0623	0499	0727	0971	0743	0678	0523	0590	0852	0697	0594	0726	0576	0709	0687	0511	0580	0524
s099	0832	0702	0558	0564	0536	0730	0587	0615	0551	0566	0725	0621	0586	0693	0539	0704	0622	0609	0549	0575
s100	0778	0673	0875	0709	0461	0699	0632	0674	0582	0567	0634	0604	0696	0574	0597	0742	0650	0730	0603	0574
s101	0918	1007	0966	0927	1122	1121	0777	0882	0932	0873	1136	0846	0915	0956	0714	1099	0993	0933	1145	0831
s102	0718	0596	0646	0510	0631	0792	0572	0722	0563	0548	0814	0619	0773	0604	0654	0857	0680	0690	0552	0421
s103	0719	0605	0671	1021	0703	0840	0680	0629	0632	0526	0778	0700	0883	0793	0589	0924	0694	0654	0710	0628
s104	1262	0742	0703	0918	0618	0771	0669	0606	0798	0517	1145	0636	0721	0594	0683	0954	0737	0787	0733	0687

* Inner-Outer - two inner-most keys textured

s105	0859	0770	1034	0746	0745	0986	0938	1020	0862	0841	0919	0880	1099	0750	0623	1157	0781	0971	0779	0809
s106	0787	0626	0564	0551	0547	0736	0476	0480	0481	0449	0823	0525	0504	0428	0420	0758	0610	0570	0438	0424
s107	0572	0474	0615	0600	0525	0676	0587	0583	0591	0410	0700	0512	0471	0488	0557	0767	0557	0437	0419	0445
s108	0692	0554	0582	0579	0544	0726	0688	0560	0482	0421	0655	0568	0527	0460	0425	0690	0600	0690	0425	0432
s109	0929	0800	1160	0832	0812	0937	0692	0996	0647	0623	0875	0726	0804	0778	0824	0864	0958	0944	0851	0699
s110	1016	0669	0881	0613	0928	0919	0750	0832	0725	0603	1066	0824	0745	0727	0503	0918	0693	0665	0666	0691
s111	0726	0615	0622	0606	0609	0803	0660	0711	0670	0434	0867	0652	0629	0613	0524	0775	0736	0649	0613	0639
s112	0718	0583	0620	0648	0537	0772	0572	0563	0462	0497	0772	0497	0569	0493	0463	0789	0594	0629	0517	0567

* Alternate - b & n keys textured

s113	1099	0848	1022	0969	0843	1010	0786	0730	0815	0922	1106	0994	1008	0921	0889	0932	0903	0734	0932	0856
s114	0747	0573	0664	0587	0586	0591	0642	0665	0752	0499	0801	0425	0638	0600	0653	0656	0554	0568	0595	0605
s115	0980	0744	0863	0862	0994	0981	0755	0759	0752	0713	1026	0851	0916	0882	0705	1062	0764	0879	0810	0685
s116	0814	0872	0727	0626	0795	1022	0743	0675	0677	0651	0886	0921	0615	0740	0706	0830	0874	0713	0572	0506
s117	0797	0747	0707	0799	0834	0862	0710	0665	0793	0678	0833	0719	0743	0749	0586	0810	0700	0762	0729	0530
s118	0775	0606	0770	0517	0524	0879	0501	0532	0466	0445	0848	0570	0623	0660	0548	0762	0718	0563	0601	0542
s119	0820	0622	0606	0589	0617	0650	0582	0588	0495	0504	0813	0556	0656	0643	0556	0762	0661	0557	0619	0542
s120	0793	0648	0715	0761	0735	0873	0759	0759	0633	0604	0843	0759	0598	0637	0568	0822	0728	0786	0685	0602

* Alternate - v & m keys textured

s121	1036	0914	0962	0784	0880	0935	0867	0945	0837	0728	0802	0825	1015	1056	0744	1037	1044	0835	0834	0612
s122	0893	0884	0970	0861	0866	1059	0836	0989	1000	0958	0977	0922	0864	0946	1088	0941	0969	0993	0907	0905
s123	0830	0627	0594	0683	0736	0840	0535	0566	0535	0502	0692	0740	0697	0637	0573	0732	0613	0645	0677	0487
s124	0563	0557	0579	0556	0514	0621	0469	0515	0554	0541	0630	0477	0462	0439	0538	0633	0528	0482	0434	0466
s125	0786	0811	0736	0887	0802	0863	0788	0714	0593	0487	0919	0804	0687	0644	0615	1048	1045	0774	0728	0488
s126	0958	0684	0807	0639	0740	0795	0636	0705	0692	0691	0869	0784	0821	0705	0718	0915	0869	0716	0705	0653
s127	0810	0542	0759	0692	0530	0766	0723	0536	0500	0453	0955	0599	0557	0570	0589	0789	0683	0579	0606	0511
s128	0951	0913	0733	0772	0808	0829	0756	0768	0858	0610	0892	0723	0856	0752	0751	0918	0800	0927	0781	0818

Reaction Time Analysis - Experiment 2

Main Effects

Source	SS	MS	df	f	p
Hand Placement	22336610.21	22336610	1	109.76	<.000
within-cells	24421132.88	203509.44	120		
Texture Placement	563235.78	187745.26	3	.92	<.432
within-cells	2441132	203509.41	120		
Precue	83957.36	27985.79	3	5.35	<.001
within-cells	1884053.18	5233.48	360		
Interval	587128.15	146782.04	4	25.53	<.001
within-cells	2759207.38	5748.35	480		

Two-way Interactions

Source	SS	MS	df	f	p
Hand Placement x Texture Placement	221340.14	73780.05	3	.36	<.780
within-cells	24421132.88	203509.44	120		
Hand Placement x Interval	160495.62	40123.90	4	6.98	<.000
within-cells	2759207.38	5748.35	480		
Hand Placement x Precue	41749.28	13916.43	3	2.66	<.048
within-cells	1884053.18	5233.48	360		
Texture Placement x Interval	69362.47	5780.21	12	1.01	<.442
within-cells	2759207.38	5748.35	480		
Texture Placement x Precue	41070.16	4563.35	9	.87	<.551
within-cells	18804053.18	5233.48	360		
Interval x Precue	10628342.76	885695.23	12	148.99	<.000
within-cells	8560188.62	5944.58	1440		

Three-Way Interactions

Source	SS	MS	df	f	p
Hand Placement x Texture Placement x Interval	108735.27	9061.27	12	1.58	<.095
within-cells	2759207.38	5748.35	480		
Hand Placement x Texture Placement x Precue	21663.07	2407.01	9	.46	<.901
within-cells	1884053.18	5233.48	360		
Hand Placement x Interval x Precue	184388.95	15365.75	12	2.58	<.002
within-cells	8560188.62	5944.58	1440		
Texture Placement x Interval x Precue	245455.87	6818.22	36	1.15	<.254
within-cells	8560188.62	5944.58	1440		

Four-way Interaction

Source	SS	MS	df	f	p
Hand Placement x Texture Placement x Precue x Interval	287668.49	7990.79	36	1.34	<.085
within-cells	8560188.62	5944.58	1440		

Percentage Error Cell Means - Experiment 2

ADJACENT HAND PLACEMENT

	UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300
* Control - all keys textured																				
s001	00.00	00.00	00.00	00.00	25.00	00.00	00.00	06.25	06.25	06.25	00.00	06.25	06.25	00.00	12.50	00.00	06.25	06.25	06.25	00.00
s002	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25
s003	00.00	00.00	12.50	12.50	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s004	00.00	00.00	00.00	12.50	12.50	00.00	00.00	00.00	00.00	00.00	06.25	00.00	12.50	00.00	00.00	00.00	00.00	06.25	00.00	00.00
s005	12.50	00.00	25.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	00.00	12.50	06.25	00.00	00.00	12.50	06.25	00.00	00.00	00.00
s006	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	25.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s007	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	00.00	06.25	00.00	00.00	06.25
s008	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	06.25	00.00	00.00	00.00
* Control - no keys textured																				
s009	12.50	12.50	12.50	12.50	12.50	18.75	12.50	00.00	00.00	12.50	12.50	12.50	00.00	12.50	06.25	06.25	06.25	12.50	06.25	00.00
s010	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00
s011	00.00	00.00	00.00	00.00	12.50	06.25	06.25	00.00	00.00	06.25	12.50	06.25	06.25	00.00	00.00	12.50	06.25	00.00	00.00	00.00
s012	12.50	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	00.00	00.00	18.75	12.50	00.00	00.00	00.00
s013	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25
s014	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	12.50	00.00	06.25	00.00	06.25	00.00	00.00	06.25	00.00
s015	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	25.00	12.50	12.50	00.00	12.50	18.75	00.00	00.00	00.00	06.25
s016	12.50	00.00	12.50	12.50	00.00	06.25	00.00	00.00	00.00	06.25	06.25	00.00	00.00	12.50	00.00	00.00	00.00	12.50	00.00	06.25
* Left-Right - two right-most keys textured																				
s017	25.00	00.00	12.50	12.50	25.00	06.25	00.00	06.25	00.00	00.00	18.75	00.00	06.25	00.00	00.00	31.25	00.00	00.00	00.00	06.25
s018	00.00	00.00	00.00	00.00	00.00	12.50	12.50	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25
s019	12.50	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	18.75	12.50	00.00	06.25	00.00	00.00	00.00	06.25
s020	00.00	25.00	12.50	00.00	00.00	00.00	06.25	00.00	00.00	06.25	12.50	00.00	06.25	00.00	00.00	06.25	00.00	12.50	00.00	00.00
s021	00.00	00.00	00.00	00.00	25.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	12.50	00.00	00.00	00.00	00.00
s022	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25
s023	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	12.50	06.25	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	06.25	06.25
s024	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	06.25
* Left-Right - two left-most keys textured																				
s025	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s026	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s027	00.00	12.50	00.00	00.00	00.00	06.25	06.25	00.00	00.00	00.00	06.25	12.50	00.00	00.00	06.25	12.50	06.25	06.25	00.00	00.00
s028	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	12.50	12.50	00.00	06.25	06.25	00.00	00.00	06.25
s029	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00
s030	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25	00.00
s031	00.00	12.50	00.00	12.50	00.00	00.00	00.00	00.00	06.25	06.25	06.25	12.50	00.00	00.00	00.00	06.25	00.00	06.25	00.00	12.50
s032	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	00.00	06.25	06.25	00.00	00.00	00.00	06.25	00.00	06.25	06.25	00.00	00.00

Percentage Error Cell Means - Experiment 2

ADJACENT HAND PLACEMENT

UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
0	37	75	150	300	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300

* Inner-Outer - two outer-most keys textured

s033	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s034	12.50	12.50	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	18.75	00.00	00.00	00.00	00.00	18.75	00.00	00.00	00.00	00.00
s035	00.00	00.00	12.50	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25	00.00	06.25	00.00	00.00
s036	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	06.25	00.00	00.00	06.25	06.25	12.50	00.00	00.00
s037	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	06.25
s038	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	00.00	00.00	00.00	06.25	06.25	06.25	06.25
s039	12.50	00.00	12.50	00.00	00.00	00.00	00.00	06.25	00.00	06.25	06.25	00.00	00.00	00.00	06.25	06.25	06.25	00.00	00.00	00.00
s040	00.00	25.00	12.50	00.00	12.50	00.00	00.00	06.25	06.25	12.50	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00

* Inner-Outer - two inner-most keys textured

s041	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	12.50	06.25	06.25	00.00	06.25	00.00	00.00	12.50	00.00	00.00	00.00	00.00
s042	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	00.00	06.25	06.25	06.25	00.00	06.25	12.50	06.25	00.00
s043	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25	06.25	00.00	00.00
s044	00.00	00.00	12.50	12.50	12.50	06.25	12.50	06.25	12.50	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	12.50	00.00	00.00
s045	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	00.00	06.25	00.00	00.00
s046	00.00	00.00	00.00	12.50	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00
s047	00.00	25.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	12.50	00.00	00.00
s048	12.50	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	06.25	00.00	06.25	06.25	06.25	12.50	12.50	00.00

* Alternate - b & n keys textured

s049	12.50	00.00	12.50	00.00	12.50	00.00	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	12.50	00.00
s050	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	12.50	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	06.25
s051	00.00	12.50	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	06.25	06.25	00.00	12.50	00.00
s052	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	00.00
s053	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	25.00	12.50	18.75	00.00	00.00	06.25	06.25	06.25	00.00	06.25
s054	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	00.00	00.00	00.00	12.50	00.00	06.25
s055	00.00	00.00	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	06.25	00.00	25.00	12.50	18.75
s056	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25

* Alternate - v & n keys textured

s057	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25	00.00	00.00	00.00
s058	00.00	12.50	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	06.25	00.00	00.00	00.00	06.25	00.00	06.25	12.50	00.00
s059	00.00	00.00	00.00	12.50	00.00	00.00	06.25	06.25	12.50	06.25	12.50	00.00	06.25	06.25	12.50	12.50	06.25	00.00	00.00	06.25
s060	00.00	12.50	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	00.00	18.75	00.00	06.25
s061	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25
s062	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	06.25	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	06.25	06.25
s063	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	18.75	06.25	00.00
s064	00.00	00.00	00.00	00.00	00.00	06.25	00.00	12.50	00.00	00.00	00.00	25.00	12.50	00.00	00.00	00.00	06.25	06.25	06.25	00.00

Percentage Error Cell Means - Experiment 2

OVERLAPPED HAND PLACEMENT

	UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300	0	37	75	150	300

* Control - all keys textured

s065	12.50	12.50	12.50	25.00	00.00	00.00	12.50	12.50	00.00	06.25	18.75	18.75	06.25	12.50	00.00	12.50	06.25	25.00	06.25	12.50
s066	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00
s067	00.00	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	06.25	00.00	06.25	06.25	00.00	06.25	12.50	06.25	06.25	06.25	00.00
s068	00.00	00.00	00.00	00.00	00.00	12.50	06.25	06.25	00.00	12.50	00.00	06.25	00.00	00.00	12.50	00.00	00.00	00.00	00.00	25.00
s069	12.50	25.00	12.50	25.00	12.50	00.00	00.00	12.50	18.75	06.25	12.50	25.00	25.00	18.75	06.25	06.25	12.50	18.75	12.50	18.75
s070	00.00	12.50	00.00	12.50	12.50	00.00	12.50	00.00	06.25	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00
s071	00.00	00.00	00.00	12.50	00.00	25.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	06.25
s072	00.00	00.00	12.50	00.00	37.50	06.25	00.00	06.25	06.25	06.25	00.00	18.75	25.00	00.00	06.25	25.00	18.75	18.75	06.25	06.25

* Control - no keys textured

s073	00.00	00.00	00.00	12.50	12.50	00.00	12.50	00.00	06.25	06.25	00.00	06.25	12.50	06.25	00.00	00.00	06.25	06.25	06.25	18.75
s074	25.00	00.00	12.50	37.50	00.00	00.00	06.25	06.25	12.50	18.75	12.50	06.25	25.00	00.00	18.75	12.50	18.75	12.50	12.50	12.50
s075	00.00	00.00	12.50	12.50	12.50	12.50	00.00	06.25	12.50	12.50	00.00	18.75	06.25	06.25	06.25	06.25	12.50	25.00	06.25	00.00
s076	25.00	00.00	00.00	00.00	12.50	12.50	12.50	00.00	25.00	00.00	12.50	00.00	00.00	00.00	06.25	06.25	00.00	06.25	25.00	06.25
s077	00.00	12.50	00.00	00.00	00.00	00.00	06.25	06.25	00.00	00.00	06.25	12.50	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00
s078	00.00	12.50	00.00	00.00	12.50	06.25	00.00	06.25	06.25	06.25	06.25	00.00	00.00	18.75	00.00	00.00	12.50	00.00	12.50	06.25
s079	00.00	12.50	12.50	00.00	00.00	12.50	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	12.50
s080	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	12.50	12.50	00.00	06.25	00.00	00.00	06.25	06.25	06.25	00.00	00.00	06.25

* Left-Right - two right-most keys textured

s081	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	12.50	06.25	00.00	00.00	06.25	00.00
s082	00.00	00.00	00.00	12.50	00.00	00.00	12.50	00.00	06.25	12.50	12.50	00.00	00.00	12.50	00.00	06.25	00.00	06.25	06.25	06.25
s083	00.00	00.00	00.00	00.00	00.00	12.50	00.00	00.00	06.25	18.75	12.50	12.50	06.25	06.25	00.00	12.50	25.00	18.75	06.25	12.50
s084	12.50	37.50	25.00	25.00	25.00	18.75	18.75	06.25	12.50	06.25	06.25	12.50	18.75	12.50	18.75	12.50	25.00	31.25	18.75	25.00
s085	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	18.75	06.25	06.25	06.25	00.00	00.00	06.25	06.25	00.00	00.00	00.00
s086	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	06.25	06.25	00.00	12.50	12.50	06.25	12.50	06.25	06.25	12.50	00.00
s087	12.50	00.00	00.00	12.50	00.00	12.50	00.00	18.75	06.25	06.25	06.25	06.25	00.00	06.25	00.00	00.00	12.50	00.00	06.25	00.00
s088	00.00	00.00	00.00	25.00	12.50	00.00	12.50	06.25	06.25	00.00	06.25	00.00	12.50	12.50	00.00	00.00	12.50	00.00	00.00	06.25

* Left-Right - two left-most keys textured

s089	12.50	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00
s090	00.00	25.00	00.00	12.50	00.00	00.00	00.00	12.50	00.00	12.50	25.00	00.00	12.50	06.25	00.00	06.25	12.50	12.50	37.50	25.00
s091	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	00.00	00.00	06.25
s092	00.00	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25
s093	00.00	00.00	00.00	00.00	12.50	06.25	00.00	00.00	12.50	00.00	00.00	12.50	00.00	00.00	00.00	06.25	12.50	00.00	00.00	12.50
s094	12.50	00.00	00.00	00.00	12.50	06.25	00.00	06.25	06.25	06.25	06.25	12.50	12.50	06.25	06.25	00.00	06.25	06.25	06.25	06.25
s095	00.00	00.00	00.00	00.00	12.50	00.00	06.25	00.00	00.00	06.25	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	00.00	12.50
s096	12.50	00.00	00.00	12.50	25.00	06.25	06.25	06.25	00.00	00.00	06.25	06.25	00.00	12.50	06.25	18.75	12.50	12.50	06.25	00.00

Percentage Error Cell Means - Experiment 2

OVERLAPPED HAND PLACEMENT

UNCUED					HAND-CUED					FINGER-CUED					NEITHER-CUED				
0	3	7	1	3	0	3	7	1	3	0	3	7	1	3	0	3	7	1	3
	7	5	5	0		7	5	5	0		7	5	5	0		7	5	5	0
	5	0	0	0		5	0	0	0		5	0	0	0		5	0	0	0
			0	0				0	0				0	0				0	0

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* Inner-Outer - two outer-most keys textured

s097	00.00	12.50	00.00	12.50	00.00	18.75	12.50	25.00	12.50	18.75	00.00	12.50	12.50	06.25	12.50	12.50	25.00	06.25	06.25	06.25
s098	00.00	12.50	00.00	12.50	12.50	06.25	18.75	00.00	06.25	00.00	06.25	06.25	12.50	06.25	00.00	00.00	00.00	06.25	00.00	18.75
s099	00.00	12.50	00.00	00.00	00.00	00.00	06.25	06.25	12.50	12.50	06.25	06.25	00.00	18.75	06.25	00.00	18.75	06.25	12.50	00.00
s100	00.00	12.50	12.50	00.00	00.00	00.00	06.25	06.25	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	18.75	00.00	06.25	00.00
s101	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	06.25	06.25	00.00	00.00	06.25	06.25
s102	12.50	00.00	00.00	00.00	12.50	00.00	12.50	00.00	00.00	25.00	12.50	18.75	00.00	06.25	00.00	00.00	00.00	12.50	00.00	12.50
s103	00.00	00.00	00.00	00.00	25.00	00.00	00.00	06.25	12.50	00.00	00.00	12.50	06.25	00.00	06.25	00.00	06.25	06.25	12.50	06.25
s104	00.00	00.00	00.00	00.00	00.00	00.00	06.25	00.00	00.00	06.25	12.50	00.00	06.25	06.25	12.50	06.25	12.50	06.25	06.25	06.25

* Inner-Outer - two inner-most keys textured

s105	00.00	00.00	00.00	00.00	00.00	06.25	00.00	12.50	12.50	00.00	00.00	06.25	25.00	00.00	06.25	06.25	12.50	00.00	06.25	12.50
s106	12.50	25.00	37.50	37.50	37.50	43.75	37.50	37.50	25.00	18.75	31.25	18.75	12.50	50.00	31.25	18.75	31.25	18.75	25.00	37.50
s107	00.00	00.00	12.50	00.00	12.50	12.50	18.75	06.25	00.00	25.00	06.25	25.00	06.25	18.75	06.25	06.25	18.75	00.00	06.25	00.00
s108	12.50	00.00	12.50	00.00	00.00	00.00	06.25	06.25	06.25	12.50	06.25	00.00	00.00	06.25	06.25	12.50	12.50	06.25	12.50	12.50
s109	00.00	00.00	25.00	12.50	12.50	18.75	18.75	12.50	06.25	00.00	12.50	18.75	06.25	00.00	00.00	06.25	12.50	12.50	06.25	00.00
s110	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	06.25	00.00	00.00	06.25	00.00	00.00	00.00	12.50	06.25	12.50	00.00
s111	12.50	00.00	12.50	00.00	00.00	06.25	06.25	00.00	00.00	00.00	12.50	06.25	00.00	00.00	06.25	18.75	06.25	12.50	00.00	06.25
s112	00.00	12.50	12.50	00.00	12.50	12.50	12.50	12.50	00.00	12.50	00.00	06.25	06.25	06.25	06.25	06.25	06.25	06.25	00.00	18.75

* Alternate - b & n keys textured

s113	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	06.25	00.00	06.25	00.00	06.25	06.25	12.50	00.00	00.00	06.25	06.25
s114	00.00	00.00	25.00	12.50	12.50	18.75	06.25	06.25	06.25	18.75	06.25	18.75	06.25	25.00	00.00	18.75	12.50	18.75	12.50	06.25
s115	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	12.50	00.00	00.00	00.00	00.00	06.25	06.25	00.00
s116	00.00	00.00	00.00	00.00	00.00	00.00	00.00	18.75	06.25	06.25	12.50	00.00	00.00	00.00	12.50	06.25	00.00	12.50	06.25	00.00
s117	00.00	00.00	00.00	00.00	12.50	06.25	06.25	00.00	06.25	06.25	00.00	06.25	00.00	00.00	00.00	00.00	06.25	00.00	06.25	06.25
s118	12.50	00.00	00.00	00.00	12.50	06.25	00.00	06.25	06.25	06.25	12.50	00.00	12.50	12.50	06.25	06.25	12.50	06.25	06.25	12.50
s119	12.50	00.00	00.00	25.00	12.50	06.25	12.50	06.25	00.00	12.50	31.25	12.50	00.00	06.25	06.25	12.50	06.25	12.50	06.25	06.25
s120	00.00	12.50	00.00	00.00	00.00	00.00	12.50	00.00	06.25	00.00	00.00	00.00	00.00	00.00	06.25	00.00	06.25	00.00	00.00	00.00

* Alternate - v & n keys textured

s121	12.50	00.00	12.50	00.00	12.50	06.25	00.00	12.50	06.25	06.25	12.50	06.25	00.00	06.25	00.00	18.75	12.50	06.25	00.00	06.25
s122	12.50	00.00	00.00	00.00	00.00	06.25	12.50	00.00	06.25	00.00	00.00	06.25	00.00	06.25	12.50	00.00	00.00	06.25	06.25	00.00
s123	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	12.50	00.00	00.00	00.00	12.50	06.25	00.00	00.00	00.00
s124	00.00	00.00	00.00	00.00	00.00	00.00	12.50	12.50	06.25	06.25	12.50	12.50	06.25	06.25	00.00	00.00	12.50	00.00	00.00	00.00
s125	00.00	12.50	00.00	12.50	00.00	00.00	06.25	06.25	00.00	00.00	06.25	06.25	06.25	00.00	06.25	12.50	00.00	12.50	00.00	00.00
s126	00.00	12.50	12.50	00.00	00.00	12.50	06.25	18.75	12.50	18.75	12.50	06.25	00.00	12.50	12.50	12.50	00.00	06.25	00.00	18.75
s127	00.00	12.50	12.50	12.50	12.50	06.25	12.50	12.50	06.25	00.00	06.25	00.00	06.25	00.00	06.25	06.25	25.00	06.25	18.75	12.50
s128	12.50	00.00	00.00	12.50	00.00	06.25	06.25	00.00	00.00	00.00	00.00	00.00	06.25	06.25	00.00	12.50	00.00	06.25	00.00	00.00

Percentage Error Analysis - Experiment 2

Main Effects

SOURCE	SS	MS	df	f	p
HAND PLACEMENT	143.93	143.93	1	32.89	≤.000
within-cells	525.14	4.38	120		
TEXTURE PLACEMENT	8.64	2.88	3	.66	≤.579
within-cells	525.14	4.38	120		
PRECUE	7.41	2.47	3	4.07	≤.007
within-cells	218.32	.61	360		
INTERVAL	80.74	20.19	4	33.18	≤.000
within-cells	291.97	.61	480		

Two-way Interactions

SOURCE	SS	MS	df	f	p
HAND PLACEMENT x TEXTURE PLACEMENT	14.57	4.86	3	1.11	≤.348
within-cells	525.14	4.38	120		
HAND PLACEMENT x INTERVAL	18.62	4.66	4	7.65	≤.000
within-cells	291.97	.61	480		
HAND PLACEMENT x PRECUE	2.28	.76	3	4.07	≤.291
within-cells	218.32	.61	360		
TEXTURE PLACEMENT x INTERVAL	3.88	.32	12	.53	≤.894
within-cells	291.97	.61	480		
TEXTURE PLACEMENT x PRECUE	2.28	.25	9	.42	≤.926
within-cells	218.32	.61	360		
INTERVAL x PRECUE	22.73	1.89	12	3.31	≤.000
within-cells	823.13	.57	1440		

Three-way Interactions

SOURCE	SS	MS	df	f	p
HAND PLACEMENT x TEXTURE PLACEMENT x INTERVAL	13.48	1.12	12	1.85	≤.039
within-cells	291.97	.61	480		
HAND PLACEMENT x TEXTURE PLACEMENT x PRECUE	2.86	.32	9	.52	≤.857
within-cells	218.32	.61	360		
HAND PLACEMENT x INTERVAL x PRECUE	18.95	1.58	12	2.76	≤.001
within-cells	823.13	.57	1440		
TEXTURE PLACEMENT x INTERVAL x PRECUE	15.70	.44	36	.76	≤.844
within-cells	823.13	.57	1440		

Four-Way Interaction

SOURCE	SS	MS	df	f	p
HAND PLACEMENT x TEXTURE PLACEMENT x INTERVAL x PRECUE	25.60	.71	36	1.24	≤.154
within-cells	823.13	.57	1440		