INSPECTION TIME

AND THE

ADDITIVE FACTORS APPROACH

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This thesis contains no material which has been accepted for the award of any degree or diploma in any university, nor any material previously published or written by another person, except when due reference to such material is made in the text.

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ABSTRACT

17 practiced subjects were required to discriminate whether a briefly displayed probe digit was a member of a previously memorised set in both a reaction time task and an inspection time task. Subject's reaction time and inspection time were measured as a function of the manipulation of a number of factors based on Sternberg's (1969) additive factors methodology (that is, stimulus quality, size of positive set, and response type required). All factor effects were found to be additive in the RT task thus replicating Sternberg's (1969) findings. The stimulus quality manipulation was found to affect IT as well as RT, yet the remaining factors did not, thus illustrating a simple experimental demonstration of the separability of processing stages. The present results provide strong empirical support for the proposition that encoding takes place temporally prior to the serial comparison stage. If one remains committed to the serial processing model, the temporal divide between early and late processing can be made prior to the serial comparison stage on the basis of Sternberg's (1969) additive factors methodology. Thus, whatever affects the IT measure includes encoding but does not include the serial comparison stage. This is compatible with the views of both Brand and Nettelbeck who maintain that IT be seen as a measure of initial sensory input.

CONTENTS

CHAPTER 1

Additive Factors Stage Theory

Additive Factors Stage Theory

Whilst much theorising as to the content and ordering of information processing stages in human cognition has been undertaken in recent years and the findings of experimental work have allowed some gains in the understanding of such processing, it is notable that little strong evidence exists which allows experimenters to claim an empirical basis for these findings. This is largely due to the fact that such experimentation has employed the RT task as the experimental tool which only allows for the inferred ordering of processing stages. The following experimentation aims to provide some empirical support for stage analysis through the combined use of Sternberg's (1969) additive factors methodology with inspection time methodology. This may allow the theoretical division between early and late processing stages to be empirically realised and hence shed light on both the content and ordering of at least some of the hypothesised stages of processing gleaned from research with the RT tool.

Sternberg (1969) made an important contribution to the field of human information processing with his discovery of processing stages, a discovery which had its beginnings in the work of Donders (1868). Donders (1868) argued that the time between stimulus and response in human information processing is occupied by a train of successive processes (or stages) whereby each stage process begins only when the preceding one has ended. Thus reaction time (RT) was seen as the sum of durations of a series of stages.

Donders (1868) proposed a subtraction method to measure the duration of some of these stages. This method involved comparing the mean RTs from two different tasks where one task is thought to require all the stages of the first as well as an additional stage. Donders (1868) took the difference between means of the two tasks to be an estimate of the mean duration of the interpolated stage. This methodology for decomposing RT thus rests on the validity of this "assumption of pure insertion" which states that changing from Task 1 to Task 2 merely inserts a new processing stage without altering the others.

Donders' (1868) methodology was popular for several decades but came into disfavour toward the end of the nineteenth century because data appeared which were suggestive of a difficulty in devising experimental tasks that would add or delete a stage, existent between stimulus and response, without also altering other stages.

In response to this criticism, Sternberg (1969) thus proposed his "additive factors methodology", a simple method of testing for additive components which, unlike Donders' (1868) scheme, did not require procedures that added or deleted stages. Sternberg's (1969) aim was to help establish the existence and properties of the RT stages and the relations among them, rather than to measure stage durations. His methodology opened up new possibilities for inferring the organisation of mental operations in human information processing from RT data.

Sternberg (1969) started by assuming that non-overlapping stages exist, which ideally have four properties :

(a) for a given input, the output is unaffected by factors affecting its duration,

(b) a stage should be functionally interesting, psychologically and qualitatively different from other stages,

(c) one stage can process only one signal at a time, and

(d) stage durations should be stochastically independent.

Sternberg's (1969) basic idea then is that a stage is one of a series of successive processes that operates on an input to produce an output and contributes an additive component to the RT. Here the mean duration of a stage depends only on its input and the levels of factors that influence it and not directly on the mean durations of the other stages. Thus Sternberg's (1969) additive factors methodology is based on the argument that if a pair of experimental manipulations have additive effects on total RT, then each experimental manipulation has its locus of effect on a different processing stage. Here either manipulation can be included or excluded without affecting the overall processing sequence. However, if the experimental manipulations have an interactive effect on RT then Sternberg claimed that these manipulations were affecting the same processing stage.

According to Pachella (1974) the assumptions about stages have several important implications for the relationship between stage durations and experimental manipulations:

> First, total reaction time is simply the sum of the stage durations. When an experimental manipulation affects the reaction time for particular information processing task, it does so by changing durations of one or more of the constituent stages of processing. Second, if two different experimental manipulations affect two different stages, they will produce independent effects on total reaction time. The effect of one manipulation will be the same, regardless of the level of the other variable. In other words the

> effects of the two experimental factors should be additive; they should not interact in a statistical sense..... Third, if two experimental factors mutually modify each other's effect, that is, if they interact in a statistical sense, they must affect some stage in common. (Pachella, 1974, p. 52)

Sternberg's (1969) additive factors methodology is firmly based upon what Marcel (1983) terms the fundamental "assumption of Perceptual Microgenesis", an assumption adopted in most theories of mental chronometry. In essence, this assumption postulates that the course of perceptual processing is linear, sequential and hierarchical. Marcel (1983) argues that this linear, sequential aspect amounts to conceiving of different kinds of representations as being derived from one another in a particular structural and temporal order. This assumption is adopted in most theories of mental chronometry. Smith (1980) argues that stage theories have certainly widened our feeling of comprehension of RT processing and the stage approach has allowed sense to be made of much data. Smith (1980) states that until clear evidence is produced which definitively separates serial processing from parallel processing in the cognitive system, it is arguable that one should continue to utilise serial processing models.

CHAPTER 2

Sternberg's Theory of Response Organisation
Derived from the RT process

Sternberg's Theory of Response Organisation Derived From the Reaction Time Process

Sternberg (1969) applied his additive factors methodology to mean RTs in a binary classification task. Here a basic experimental paradigm was followed in which, on each sequence of trials, the subject was presented visually with a digit as the test stimulus where the ensemble of the possible test stimuli consisted of the digits 0-9. The ten digits were used as stimuli because they are well-learned and highly discriminable. On each trial the subject was required to make a positive response if the test stimulus was a member of a small, memorised set of digits (the positive set) and a negative response otherwise. In this paradigm it was the identification of the stimulus that was relevant to the binary response rather than the order in the sequence in which the stimulus occurred. Errors were held to 1 percent or 2 percent by the use of payoffs which stressed accuracy heavily relative to speed. The basic experimental paradigm was based on a varied-set procedure or fixed-set procedure. The varied-set procedure required that the subject be exposed to a different positive set at the beginning of every trial. The digits in the positive set were presented at the rate of 1.2 seconds per digit at a fixed locus followed by the presentation of the test stimulus and the subsequent subject response. The fixed-set procedure merely required that the subject learn and remember the members of the positive set prior to experimental trials for each experimental series. The response latency is defined as the time from the onset of the test stimulus to the occurrence of the response.

Sternberg's (1969) experimental results comparing the effect of this differing procedural methodology are shown to be essentially identical for both procedures. This remarkable similarity of results from the two procedures indicates, according to Sternberg (1969), that the same retrieval process was used for both the unfamiliar and the well-learned lists.

Using this paradigm, including both varied- and fixed-set procedures for presentation of the members of the positive set, Sternberg (1969) proposed an information processing sequence based on the manipulation of four experimental factors:

Factor 1) *Stimulus quality* . Here, the digit was either presented normally (intact) in some trials or with a checkerboard pattern superimposed over the test stimuli (degraded) in others.

Factor 2) *Size of positive set* . The size of the positive set was either varied from trial to trial containing from 1-6 digits or it was fixed throughout a series of trials and contained one , two, or four digits, each subject having a series of each set size. Previous work had shown a linear increase of mean RT with increase in set size.

Factor 3) *Response type (positive or negative)* . The level of this factor was determined by whether the test stimulus presented was a member of the positive set. Only correct responses were used in analysis.

Factor 4) *Relative frequency of response type* . The relative frequency with which positive and negative responses were required was varied between blocks by the manipulation of the proportion of trials on which the test stimulus was a member of the positive set.

Sternberg (1969) cites four experiments concerned with the manipulation of the above factors. However, for the purpose of the present experimentation, only the first three of Sternberg's (1969) cited experiments will be discussed in detail. The final experiment (Experiment IV) manipulated the relative frequency of response type factor, a factor whose effect lies outside the requirements of the present experimental aims. However, to gain an overall picture of Sternberg's (1969) view of the stages involved in human information processing, it should be noted that Sternberg (1969) suggests that the manipulation this factor affects a final and independent stage in the overall sequence of processing, the translation and response organisation stage.

In experiment I the positive set was varied from trial to trial and contained from one to six digits. Experiments II and III employed the fixed-set procedure, with sets containing either one, two, or four digits, each subject having a series at each set size.

Factors 2 and 3 (size of positive set and response type) were studied in experiments I and II (Sternberg, 1966). Sternberg (1966) found that his subjects' mean RT increased linearly with the length of the "to-be-remembered" sequence. This linearity of the latency function led Sternberg (1966) to suggest that the time between test stimulus and response is occupied, in part, by a serial comparison (scanning) process. That is, an internal representation of the test stimulus is compared successively to the symbols in memory, each comparison resulting in either a match or a mismatch. Sternberg (1966) further concluded that this scanning process was exhaustive rather than self-terminating. That is, even when a match has occurred, scanning continues through the entire series. Thus, the slope of the latency function represents the mean comparison time. Experiments I and II provided a measure of the speed of purely internal events, independent of the time taken by sensory and motor operations and provide empirical evidence as to the additivity of the factors size of positive set and response type.

Factors 1, 2, and 3 (stimulus quality, size of positive set, and response type) were examined in experiment III (Sternberg, 1967). Experiment III was a character classification task in which test stimuli were either intact (normal) or degraded by a superimposed pattern. From his results, Sternberg (1967) concluded that there appeared to be at least two separate operations involved in the classification of a character. The first encodes the visual stimulus as an abstracted representation of its physical properties and the second compares such a representation to a memory representation, producing either a match or a mismatch (Sternberg's exhaustive scanning, 1966). Results from experiment III indicate that degradation of the test stimulus produced a cost in terms of time. This increase in mean RT resulting from degradation (Factor 1) was about 70 msec, regardless of the size of the positive set (Factor 2) and regardless of the response type required (Factor 3).

As previously mentioned, the final experiment reported in Sternberg's (1969) study yielded results which led Sternberg to purport that the manipulation of the relative frequency of response type factor has its locus of effect in a final stage, the translation and response organisation stage.

In summary, the results showed that in all cases the data were well-fitted by an additive factors model. The following factor pairs were all found to be additive:

a) stimulus quality and size of positive set
b) size of positive set and response type
c) stimulus quality and response type
d) size of positive set and relative frequency of response type
e) response type and relative frequency of response type

Sternberg (1969) argues that at least four distinct processing stages are required to account for the effects of the factors studied and these discrete stages are diagrammatically represented in Figure 1.

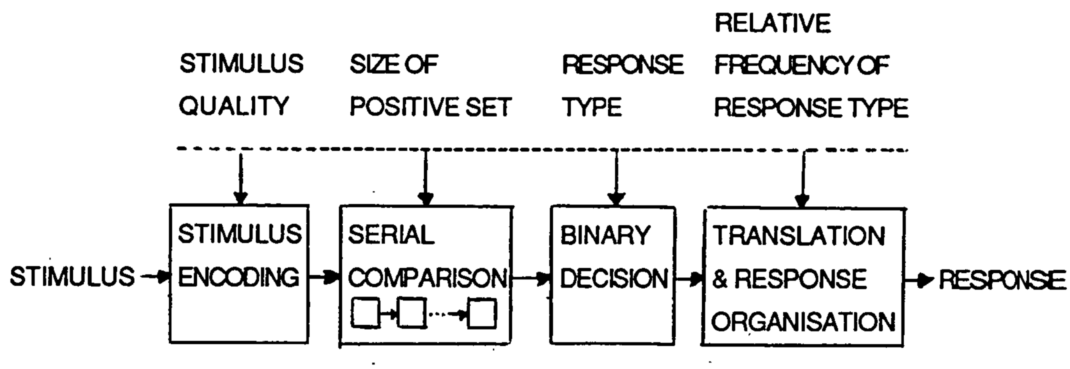

Figure 1 : Sternberg's (1969) processing stages in binary classification. Above the broken line are shown the four factors examined. Below the line is shown the analysis of RT.

The quality of the test stimulus influences the duration of the encoding stage in which a stimulus representation is formed. The stimulus representation is then used in a serial comparison stage whereby it is compared to a memory representation of all members of the positive set. Since the duration of this stage depends linearly on the size of the positive set, the serial comparison stage can be viewed as consisting of a number of substages. In Sternberg's (1967) third proposed stage, a binary decision is made that depends on whether a match or a mismatch has occurred during the previous stage. Here, mean RT is longer for negative than for positive decisions. A response based on this decision is selected in the final stage of processing.

It was possible to infer these four different stages only because of the additive relationships between the pairs of variables. Had pairs of variables interacted, then it would have been assumed that these pairs were affecting common stages of processing, and a lesser number of processing stages would have been indicated.

While Sternberg's methodology allows for the theoretical ("inferred") division of processing stages, his methodology cannot facilitate an empirical knowledge of the actual ordering of these stages within overall RT. Rather, by using his additive factors logic what Sternberg (1969) has attempted to do is to identify the most plausible ordering of discrete processing stages through the effect which manipulation of the task or the subject had on overall RT.

Sternberg (1969) arrived at his serial stage model by combining the inferences from the additive factors method with supplementary arguments and conjectures to infer the functions and likely ordering of the stages in information processing. Firstly, Sternberg (1967) argued that the stage influenced by stimulus quality is most simply interpreted as a preprocessing or encoding stage which prepares a stimulus presentation to be used in the serial comparison process. This is logically based on the empirical premise that stimulus quality influences RT without also affecting the time per comparison. Sternberg (1969) stated that any other arrangement is less plausible.

Sternberg (1969) proceeded further in his theorising, stating that the purpose of the serial comparison stage must be to provide information for response selection and thus any stage that depends on such information (for example, the stage influenced by the response type factor) must logically follow the serial comparison stage.

Thus through logical inference, the information processing sequence may be viewed as a serial progression of independent stages, with each of these stages receiving an input from a previous stage, transforming it and passing it along to the next stage.

CHAPTER 3

The Validity of Processing Stages Theory

The Validity of Processing Stages Theory

Subsequent to Sternberg (1969) there have been a number of proposals advanced for the purpose of dividing the information processing sequence into different components (e.g. Theios, 1975; Sanders, 1975; Jensen and Munro, 1979; Welford, 1980). All are based on the assumption made by Donders (1868) that each component involves a cost in terms of time, and all tend to vary only slightly in their definitions of the functions of their constituent stages.

It is useful to briefly review the basic tenets of Theios's (1975) general theory of the components of response latency theory since it is based on a similar serial stage logic as Sternberg's (1969) conception of processing. Theios's (1975) theory assumes that to differentially respond to a stimulus, a serial sequence of transformations of the stimulus information takes place in the organism before the response emerges. Theios (1975) identifies the following components of response latency in human information processing, each involving a cost in terms of time : 1) stimulus input; 2) stimulus identification; 3) response determination; 4) response program selection; 5) motor response output.

Theios (1975), like Sternberg (1967), also argues that identification time is inversely related to the clarity of the physical stimulus. Increased reaction time due to the use of a degraded stimulus is, according to Theios (1975), presumably due to increased time taken to identify a relatively ambiguous stimulus. Theios's (1975) first two proposed stages may thus be equated with Sternberg's (1969) first stage.

A plethora of experimental work has been undertaken in an attempt to build an empirical base to provide support as to the validity of processing stages theory. There are a number of consistent results on mean RT based on Sternberg's (1969) logic which suggest at least three additive components in the choice reaction process. These may be tentatively labelled as encoding, response choice, and motor adjustment (Sanders, 1975). Sternberg's proposed stimulus encoding stage is comparable to Sanders' encoding stage and his binary decision stage may be viewed as a component of Sanders' response choice stage. Sternberg's translation and response organisation stage would include the motor adjustment component of Sanders' conception of processing.

CHAPTER 4

Inspection Time as a Tool in the Theoretical Stage Division of the Information Processing Sequence

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Although the traditional tool in the study of the speed of information uptake and manipulation is the RT methodology, in relatively recent years, a new development in the field of information processing has arisen, that is, the development of the measure termed "inspection time" (IT) (Vickers, Nettelbeck, and Wilson,1972). This is a development which may allow for the experimental rather than merely theoretical division of early and later processing stages.

Both Nettelbeck (1987) and Brand (Brand & Deary, 1982), the two main theorists concerned with the theoretical importance of IT as a cognitive process, maintain that one should see IT as measuring the rate of sampling of sensory input in the initial stages of information processing. Nettelbeck's theory is based on Vickers' (1970) accumulator model for discriminative judgement. This model postulates that when required to discriminate between alternatives, subjects make a series of 'inspections' of sensory input, storing data obtained in memory until the evidence favouring one particular outcome reaches a predetermined criterion. The inspections are made at a constant rate and the time for one inspection is termed the IT. Brand, disdaining information processing models, describes IT as the "speed of apprehension of the most elementary information" (Brand & Deary, 1982) and considers it an index of general intelligence (g). The measurement of IT is possible due to the backward masking procedure which limits exposure duration of sensory stimulation and controls the amount of related information available for central processing by disrupting iconic storage of input (Nettelbeck and Kirby, 1983). The proportion of subject's correct responses at various durations of the stimulus exposure are used to calculate IT. Thus it would seem plausible to assume, as do Nettelbeck and Brand, that IT is a measure of sensory input in the initial stages of information processing, that is, equivalent to Theios's first stage, stimulus input.

Smith (1980) argues that studies of perception with backward masking suggest that, to form an adequate representation of the stimulus, it needs to be presented for an appreciable though brief period and the minimum adequate duration (Kahneman, 1968; Vickers et al., 1972) can be considered as measuring a stimulus preprocessing stage.

However, the recent research of Mackenzie, Molloy, Martin, Lovegrove, and McNicol (in press) suggests that IT includes the time taken for processing at least to the level of lexical access. The authors replicated an established RT effect (Posner & Mitchell, 1967) with the IT measure. Here IT for matching pairs of letters that were only lexically the same (Aa) was significantly longer than matching pairs that were physically identical (AA), a finding paralleled in the RT research. This difference in terms of time has been attributed in the RT literature to the greater amount of encoding required to make the former lexical judgement rather than the latter physical only decision (Posner & Mitchell, 1967). These more recent results thus indicate that IT, too, is sensitive to the demands of processing at least to the level of lexical access.

Thus, IT clearly indexes more than mere sensory input which has raised the question of whether it indexes a whole range of processing stages.

Hunter (1988) undertook an investigation of the cognitive content of the IT measure and hence its place in the overall range of proposed processing stages. It was thought that a way to investigate the early processing stage theory would be to find a factor that was known to influence very late processing stages and determine if it also influenced IT. The factor manipulated by Hunter (1988) to this end was stimulus-response (S-R) compatibility, a phenomenon which had been found to influence RT in the later processing stages. A straightforward way which was known to manipulate S-R pairings (the reversal of the spatial correspondence between the stimulus and the response) was used in Hunter's (1988) attempt to fractionate the processing sequence. Wallace (1971) had produced evidence to support a conclusion that the positions of both the stimulus and the response are related to a spatial code and that the outcome of a comparison between their representations in this code yields the difference in RTs between compatible and incompatible conditions. Another factor, the hands crossing manipulation, was also employed by Hunter (1988), a factor which has convincingly shown the role of spatial compatibility between the side of the stimulus and the side of the response. Nicoletti et al. (1982) suggested that here the use of two conflicting codes for the position of the hand and the side of the body with which the hand is connected, had a cost in terms of time, thus effectively lengthening overall RT.

Hunter (1988) measured subject's reaction time, inspection time, and movement time (the time to move the finger from the home button to the target button, following Jensen & Munro, 1979), as function of S-R compatibility. By employing the S-R pairing manipulation, including a hands crossed manipulation, the main objective of Hunter's (1988) experimentation was thus to attempt to test the early stage theory by comparing spatially corresponding and non-corresponding stimulus response arrangements in both IT and RT versions of a 2-choice task. It was thought that if the IT procedure did indeed index processing mainly in the earlier portions of the cognitive sequence, then IT measurements would be relatively unaffected by this manipulation. If IT was not affected by S-R compatibility, yet RT was, then this would in effect be the simplest experimental demonstration of the separability of processing stages. RT measurements were expected to be much more strongly affected since more cognitive work would need to be done in the late stages of processing when stimulus and response keys did not correspond. If IT was affected by S-R compatibility, this would show that stimulus input cannot be separated from Theios's entire cognitive sequence.

Hunter's (1988) results seemed to show that the S-R compatibility manipulation affected RT and IT in a similar fashion. There was a significant effect of S-R compatibility on both RT data and IT data, with incompatible responses taking significantly longer to process than compatible responses for both tasks. This finding was interpreted as providing empirical evidence that the cognitive sequences involved in IT (as based on Theios's conception) could not be restricted to an early processing stage, and that IT, like RT, indexes several processing stages, a finding which was claimed to be in conflict with earlier theorising as to the nature of IT.

However, the strength of the the findings of the Hunter (1988) study may be questioned since the effect of practice upon the IT measure was not considered there. Sanders (1977) suggests that relatively unpracticed subjects may well show different relations between task variables and cites the findings of Sternberg (1969), who observed an interaction between S-R compatibility and stimulus quality which disappeared after practice, as evidence in support of this hypothetical claim. Thus change in the composition of processing stages as a function of practice needs to be addressed in any further study which attempts to empirically divide the response sequence into discrete processing stages. Indeed further follow-up experimentation including the effect of practice on the Hunter (1988) IT task is needed to test the suggestion that IT may change as the consequence of practice by subjects. Lally and Nettelbeck (1980), in their study of the effects of intelligence and response strategy on the IT measure, found that IT was not significantly influenced by response requirements in practised individuals with normal intelligence. Longer IT estimates in Lally and Nettelbeck's (1980) more complex response condition were found only among practised subjects with an intellectual disability.

CHAPTER 5

The Present Study

The Present Study

The purpose of the present study is to investigate further the content and ordering of information processing stages through the employment of the IT methodology. For this purpose, IT methodology will be combined with the logic of additive factors methodology. The task would be to manipulate a factor which affected an early processing stage and to manipulate a number of factors which affected later processing stages and investigate the effects of these factors on IT, a similar logic to the Hunter (1988) study except that the effect of practice on the IT measure would be investigated. Replicating the basic theoretical findings involving the first three of Sternberg's (1969) factors with the RT measurement and then applying the same manipulations in the IT task would perhaps illustrate how RT may be varied without changing IT (since IT is thought to involve processing merely in the early stages of the total RT sequence) and hence provide empirical evidence in support of the validity of the concept of the fractionation of the processing sequence into early and late processing stages.

Based on what is known of the properties of IT , one would expect that IT would be affected by the manipulation of stimulus quality, Sternberg's first factor. Stanners, Jastrzembski and Westbrook (1975) found that reducing stimulus quality by placing a random dot mask over a target was found to increase response latency in a lexical decision task by a relatively constant 120 msecs. One would expect, like Sternberg (1969,) that stimulus quality would have its locus of effect in very early stages of encoding, making the stimulus harder to initially encode before any processing can occur. The hypothesis, based on what is presently known of the properties of IT, would be that IT would be increased by deterioration in stimulus quality, since all manipulations affecting initial stimulus encoding seem to influence IT in the the same direction as they influence RT.

However, if IT is a measure of early processing only, then one would expect the IT measure to be unaffected by the manipulation of factors that affect later stages in the processing sequence. If, however, IT is found to be affected by these factors thought to have their locus of effect in the later processing stages (the serial comparison stage, the binary decision stage or the translation and response organisation stage) then this would cast serious doubt on whether IT does indeed index processing mainly in the earlier portions of the processing sequence. Moreover, if there is a resultant interaction between stimulus quality and any of the other three Sternbergian factors in the IT task, then this would seriously undermine the applicability of serial stage analysis to processing under conditions of rigorous backward masking.

On the basis of the literature presented here, and adhering to the serial processing assumption held by Sternberg (1969), the following hypotheses are made :

(1) The factor of stimulus quality (manipulated by degrading the target stimuli) will influence both RT and IT measures.

(2) The factor of size of the positive set will influence RT only.

(3) The factor of response type (positive versus negative) will influence RT only.

(4) All effects will be additive.

CHAPTER 6

Method

METHOD

Apparatus

Stimuli were presented on a visual display unit and responses were made by pressing either of two buttons on a response panel, the button on the left indicating a "no" response and the button on the right indicating a "yes" response. Stimuli were controlled by an IBM-compatible micro-computer which was situated beside the subject's display terminal.

Subjects

Twenty Psychology I students at the University of Tasmania, between the ages of 18 and 50 years, were paid to take part in the study. Each subject participated in two two-hour sessions. All subjects had normal or corrected-to-normal visual acuity and remained naive with respect to experimental aims. Further, all subjects had had previous experience with similar experimentation.

Design

The design was wholly within subject, with each subject participating in two tasks : a reaction time task and an inspection time task.

The RT task was performed under eight conditions based on three factors in a fully crossed factorial design : stimulus quality (intact vs. degraded) x size of positive set (two vs. four items) x response type (positive vs. negative; positive if it was a member of the memorised set or negative if it was not a member). Stimulus quality and size of positive set were factors which varied between blocks, leaving response type the only within block factor. Thus the design for the RT task was a 2 x 2 x 2 factorial design.

The IT task had a similar design excepting that it included the manipulation of another factor, exposure duration of the test stimulus, which had five different levels. These levels of exposure duration were 0 msecs, 20 msecs, 40 msecs, 80 msecs, and 160 msecs. The zero exposure duration was included to investigate the effects of possible response bias on performance. Exposure duration and response type varied at random between trials in a block with the remaining two factors being varied between blocks (as in the RT task). Exposure duration was a procedural rather than a design factor; change in performance across exposure durations was the basis for estimating IT in each cell of the 2 x 2 x 2 design.

Procedure

There were two sessions for each subject; RT and IT tasks were both run within each session, their order of presentation being counterbalanced between subjects and over sessions. The between block factors of stimulus quality and size of positive set were also counterbalanced between subjects and over sessions. Size of the positive set blocks were always presented consecutively (that is, four blocks of the two-member set and then four blocks of the four-member set), with the stimulus quality manipulation alternating every two blocks. Both RT and IT tasks employed Sternberg's (1966, 1967) fixed-set procedure and subjects were asked to remember the same positive sets for both tasks. The relative frequency of "yes" and "no" trials (trials in which the probe stimulus was or was not in the positive set) was kept at 50% in every block of trials

Ordering of the possible ten digits composing the positive sets was derived randomly. These sets were counterbalanced in a Latin Square across subjects and differed between sessions for each subject. These positive sets for the final 20 subject sample are displayed in Appendix A.

RT Task : A trial consisted of the following events : (a) an intertrial interval of two seconds ; (b) a warning signal for

0.5 seconds ; (c) display of the test stimulus for 50 msecs ; (d) subject's response ('yes" or "no" by button press) ; and finally (e) feedback bell for 0.75 seconds from the occurrence of the response (high tone for a correct response and low tone for an incorrect response). The RT trials had accuracy-loaded instructions and were presented in eight blocks of 64 trials each session. There were 64 practice trials at the beginning of the RT trials in each session based on a memorised positive set consisting of three digits.

All subjects were required to maintain a criterion accuracy level of fewer than 10% errors in every block of the RT task to be retained in the overall experiment. Several subjects were excluded from the experiment on these grounds partway through the procedure, and were replaced by others to fill the 20 subject design.

RT was measured as the time taken between stimulus onset and the subject pressing either of the response buttons.

IT Task : This task used the same stimuli and conditions as the RT task with the procedural difference that the test stimulus was shown for a variable duration (0, 20, 40, 80 or 160 msecs) before being covered by a non-alphanumeric pattern mask. The masking characters varied randomly between trials from a set of nine. A trial, then, consisted of the following events : (a) an intertrial interval of two seconds; (b) a warning signal for 0.5 seconds ; (c) display of the test stimulus for the required exposure duration before the onset of the mask; (d) subject's response ('yes" or "no" by button press) ; and finally (e) feedback bell for 0.75 seconds from the occurrence of the response (high tone for a correct response and low tone for an incorrect response). The subjects were told to respond as accurately as possible and that speed of response was not important. Subjects were given the same feedback as in the RT task.

IT trials were presented in 16 blocks of 60 trials, with two sessions for each subject. IT practice consisted of 60 trials at the beginning of the IT trials in each session also based on a memorised set of three digits.

Inspection times were derived from the IT data by a computer-controlled procedure which fitted the accuracy data across exposure durations for each subject to a cumulative normal distribution, thereby yielding critical exposure durations (inspection times) for various accuracy levels. For this experiment, inspection trials were extrapolated to an accuracy level of 75%.

CHAPTER 7

Results

RESULTS

Overall mean percentage error for the RT task was 2.8%.

Unfortunately, three subjects had extreme IT scores, falling more than 3.5 s.d. above the mean on one or more of the 16 IT conditions. When the means and s.d.s on those variables were calculated with the extreme scores excluded, the extreme scores ranged from 7 to 21 s.d. above the rest. The three subjects were therefore considered outliers and dropped from the analysis. Raw IT data for the whole sample (20 subjects) is included in Appendix B.

The proportion of outliers may have been higher than usual because of the length and tedium of the experiment, which took two 2-hour sessions. Several subjects commented on the difficulty of maintaining full attention. The outliers may merely have been those most affected by the tedium.

Reaction Time Data

Raw data for the 17 retained subjects for the RT task including all factors (session, stimulus quality, size of positive set, and response type) are shown in Appendix C.

An analysis of variance was performed on the raw RT data of the 17 subjects and is summarised in Table 1. Here it can be seen that all four experimental factors had a significant main effect on RT as follows :

1) Session (practice effect) : Mean RT in session 1 was 579 msecs (s.d. 106 msecs), declining to 542 msecs (s.d. 94 msecs) in session 2, a mean difference in responding of 37 msecs. Thus the subjects became significantly faster at the task with greater exposure to it.

2) Stimulus quality : Mean RT to degraded stimuli (570 msecs, s.d. 103 msecs) was 20 msecs longer than RT to the intact target stimuli (550 msecs, s.d. 99 msecs) indicating that degradation of the probe results in a cost in terms of time.

3) Size of the positive set : Mean RT for sets containing only two members (522 msecs, s.d. 78 msecs) was significantly faster than mean RT for sets containing four memorised digits (598 msecs, s.d. 109 msecs), a difference of 76 msecs.

4) Response type : Mean RTs here showed a significant difference of 55 msecs between having to respond in either an affirmative fashion (mean RT for "yes" responses was 533 msecs, s.d. 95 msecs) or in a negative fashion (mean RT for "no" responses was 588 msecs, s.d. 102 msecs) , a difference in terms of time favouring the "yes" responses.

Table 1 : Analysis of variance for 17 acceptable subjects in the RT task

Summary of all effects
Design : 1-session x 2-quality x 3-setsize x 4-resptype

Effect	df Effect	MS Effect	df Error	MS Error	F	p
1	1	91988.3	16	7591.8	12.1	0.0033
2	1	27198.2	16	2077.7	13.1	0.0025
3	1	0.39E+06	16	4561.9	86.1	0.0000
4	1	0.20E+06	16	3357.6	60.7	0.0000
12	1	15.5938	16	2158.3	0.0	0.8931
13	1	4080.53	16	7016.5	0.6	0.4627
23	1	841.531	16	814.7	1.0	0.3259
14	1	1419.34	16	774.5	1.8	0.1922
24	1	14.4219	16	647.4	0.0	0.8549
34	1	1492.06	16	967.6	1.5	0.2306
123	1	5949.38	16	1712.2	3.5	0.0778
124	1	31.6719	16	331.0	0.1	0.7545
134	1	392.781	16	542.9	0.7	0.4120
234	1	503.000	16	446.0	1.1	0.3046
1234	1	2246.67	16	541.9	4.1	0.0560

Thus mean RT within the task was significantly affected by all factors within the analysis (session, stimulus quality, size of the positive set, and response type). However, none of the interactions between these four factors approached significance in the RT analysis.

Inspection Time Response Data at Zero Exposure Duration

The zero exposure trials were included in the IT procedure as a check on response bias. If subjects respond randomly when the stimulus is not exposed at all prior to the mask, the characteristics of the response distribution should conform to the binomial distribution. That is, from the normal approximation, with a probability (p) of a correct response equal to 0.5 and an n of 24 trials in a block, the mean number of correct trials should be (pn =) 12, with a variance of (pqn =) 6. If the distribution of responses differs from this, it provides evidence of response bias. Response bias is the tendency for subjects to respond "yes" or "no" more frequently than chance level in the absence of information.

Appendix D shows the raw IT data for number correct at zero exposure duration for all 16 variables.

Upon closer inspection of the mean number correct at zero exposure duration for all 16 variables, tabled in Appendix E, it was found that two of the 16 variables had means that deviated significantly from the expected value of 12/24 correct at zero exposure duration. Two of the conditions, that is, showed a general tendency across subjects for more responses of one type ("yes" or "no") than would be expected by chance. All 16 variables, however, had significantly higher variances ($p < 0.02$ by Chi square test, Weatherburn, 1957) than would be expected, indicating that there were more extreme scores than would be the case if they were responding randomly. The implication is that in every condition, subjects displayed response bias, some displaying a bias for responding "yes" , some towards responding "no".

Since the IT results relating to the response type factor would be contaminated by such biasing strategies, it was decided to collapse the IT results over the response type factor.

Inspection Time Data

The raw IT data are included in Appendix B.

An analysis of variance of the IT measurements is presented in Table 2.

Table 2 : Analysis of variance for 17 acceptable subjects in the IT task collapsed over the response type variable

Summary of all effects
Design : 1-session x 2-quality x 3-setsize

Effect	df Effect	MS Effect	df Error	MS Error	F	p
1	1	2.82035	16	0.4553	6.2	0.0230
2	1	11.2243	16	0.3821	29.4	0.0001
3	1	0.63095	16	0.2115	3.0	0.1002
12	1	0.05683	16	0.3710	0.1	0.7007
13	1	0.25463	16	0.2384	1.1	0.3178
23	1	0.43601	16	0.1434	3.0	0.0973
123	1	0.01896	16	0.2580	0.1	0.7791

This analysis indicates the existence of significant main effects for both session and stimulus quality factors.

1) Session (practice effect) : Mean IT for the second session was 28 msecs (s.d. 12.6 msecs), significantly faster (by some 5 msecs) than mean IT for the first session of 33 msecs (s.d. 14.0 msecs). Thus subjects' mean IT improved over sessions.

2) Stimulus quality : When the probe stimuli were degraded, the mean IT required to accurately detect these stimuli (35.5 msecs, s.d. 14.3 msecs) was significantly longer than mean IT required for detection of the intact target stimuli (25.9 msecs, s.d. 10.8 msecs). Thus degradation of the target stimuli resulted in a cost in terms of time for accurate detection of the stimuli.

Mean IT for positive sets containing two digits was 29.6 msecs(s.d. 13.6 msecs) and mean IT for four member positive sets was 31.8 msecs (s.d. 13.4 msecs). This difference between these two measures did not approach statistical significance ($F(1, 16) = 2.98$, $p > 0.10$). Hence set size does not appear to have a significant influence on IT. Further, there were no significant interactions at the 0.05 level between the factors of session, stimulus quality, and size of the positive set.

CHAPTER 8

Discussion

DISCUSSION

A logically ordered discussion of the empirical findings necessitates that the results of the reaction time task, and their resultant implications for theory, be reviewed first.

The findings of the present experimentation replicate the overall findings of Sternberg's (1969) first three cited experiments.

First, from the analysis of the results of the reaction time task it can be seen that the manipulation of the stimulus quality variable had a significant effect on the length of reaction time to the target stimulus. Degradation of the target stimulus resulted in a cost in terms of time of 20 msecs, as compared with responses to an intact stimulus. This is not as great a cost as in the Stanners et al. (1975) study, which reports an increase of 120 msecs when the stimulus is degraded, yet it is highly statistically significant.

Second, the hypothesis based on Sternberg's (1969) previous findings regarding the outcome of the manipulation of the set size factor is also supported here. That is, as hypothesised, the four-member fixed positive set condition yielded significantly longer RTs than the two-member set condition. Sternberg (1969) argued that the set size factor has its locus of effect in the serial comparison stage whereby the stimulus representation is compared to a memory representation of all members of the positive set resulting in the duration of this stage depending linearly on the size of the positive set. On the basis of this logic, it may be concluded that since the four-member set involves more comparisons than two-member sets, and hence more processing substages, a lengthening of overall response time results.

Third, the results of the reaction time data further replicate the empirical findings of Sternberg (1969) in that the manipulation of the response type factor had a significant effect on the reaction time measure. That is, subjects' responses to experimental trials which required a positive response were speedier than the responses to those trials which required the subject to respond in a negative manner. Thus saying "no", that the target stimulus was not a member of the previously memorised set, has a cost in processing time.

The Sternberg (1969) study further held that the manipulation of the experimental factors (stimulus quality, size of positive set, and response type) would have additive effects on the RT measure, a hypothesis also confirmed in the present experimentation. The following factor pairs were found to be additive in the present study:

a) stimulus quality and size of positive set;

b) size of positive set and response type;

c) stimulus quality and response type;

thus representing a direct parallel of Sternberg's (1969) findings. Hence the present findings confirm Sternberg's (1969) numbering of stages.

The inclusion of practice as an experimental factor showed that whilst RTs did become faster with practice, the RT measure was still significantly affected by the manipulation of all other factors included in the study.

The purpose of the manipulating the IT measure in the present experimentation was to attempt to give specific empirical evidence concerning the above process of logical inference about stage ordering and independence. Since it is generally agreed (Nettelbeck) that the IT phenomenon is a measure of the time needed for cognitive processes at an early stage in the information processing sequence, it was hypothesised that the IT measure would be affected by the manipulation of the stimulus quality factor. Sternberg (1969) argued that one would expect that the stimulus quality factor would have its locus of effect in very early stages of encoding, making the stimulus harder to initially encode before any processing can occur. It was thought that if the IT procedure did indeed index processing mainly in the earlier portions of the cognitive sequence, then IT measurements would be relatively unaffected by the manipulation of a factor thought to have its locus of effect in later processing stages. It was hypothesised that if IT was not affected by the manipulation of the set size factor or the response type factor, yet RT was, then this would in effect be the simplest experimental demonstration of the separability of processing stages.

The results of the inspection time data indicate that degradation of the target stimulus does indeed result in longer inspection times for the degraded stimulus. That is, extra processing time is needed to accurately detect the degraded stimulus. This cost was found to be around 10 msecs, about half the cost reflected in the RT data.

As hypothesised, the stimulus quality manipulation, along with the practice factor, was the only factorial manipulation which had a significant effect on the IT data. The IT measure was found to remain unaffected by the manipulation of the set size factor and, in addition, the stimulus quality and set size factor pair was found to be additive. Although ITs were shown to be affected by amount of practice at the task, the effects of the principal experimental manipulations were consistent over both sessions.

Because of the existence of response bias in the IT task, the present experimentation was unable to test for the effect of the response type factor on the IT measure. The early versus late processing hypothesis predicts that the manipulation of the response type factor would not affect the IT measure since its locus of effect is thought to be further along the serial sequence of processing stages. If one adheres to Sternberg's (1969) conjecture that the stage affected by the response type manipulation (the binary decision stage) logically follows that stage concerned with serial comparison (the serial comparison stage), then it is arguable, in any case, that this finding is of lesser theoretical importance. Since it has been shown that something in the logical scheme further down the processing sequence (set size effect), yet before the response type locus of effect, does *not* affect the IT measure, then this would logically exclude the response type manipulation as a factor able to affect the IT measure.

Since IT was not affected by the manipulation of the set size factor, yet RT was, then it may be claimed that these results provide the simplest experimental demonstration of the separability of processing stages. The present results provide strong empirical support for the proposition that encoding takes place temporally prior to the serial comparison stage. Thus, whatever affects the IT measure includes encoding but does not include the serial comparison stage. Therefore if one remains committed to the serial processing model, the temporal divide between early and late processing can be made prior to the serial comparison stage on the basis of this additive factors methodology. This gives some basic idea of how much thinking can be done before the backward mask interrupts processing. It is known that IT is concerned with early processing to the level of lexical access (Mackenzie et al., in press). On the basis of the present results, this process may now be assumed to affect processing prior to memory scanning, a process that, according to additive factors methodology results, has its locus of effect on a separate processing stage, the serial comparison stage.

On the basis of the present results obtained using additive factors methodology, and if one accepts the serial model of processing, it may be claimed that encoding affects a processing stage prior to the process concerned with memory scanning, as Sternberg held in his 1969 study. This present study claims the empirical divide between early and later processing through the employment of additive factors methodology coupled with the IT backward masking methodology. Although not all the properties of the IT phenomenon are known at this stage in the short history of its experimental use and manipulation, what one may claim here is the empirical rather than merely theoretical divide between stimulus input and the remainder of Theios's entire cognitive sequence.

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Appendices

Appendix A : Positive sets for all 20 subjects for both sessions

	Session 1			Session 2		
Subject 1 :	4128	03	597	9703	28	641
2 :	9703	28	641	4128	03	597
3 :	6412	70	859	5970	12	364
4 :	5970	12	364	6412	70	859
5 :	3641	97	285	8597	41	036
6 :	8597	41	036	3641	97	285
7 :	0364	59	128	2859	64	703
8 :	2859	64	703	0364	59	128
9 :	7036	85	412	1285	36	970
10 :	1285	36	970	7036	85	412
11 :	4128	03	597	9703	28	641
12 :	9703	28	641	4128	03	597
13 :	6412	70	859	5970	12	364
14 :	5970	12	364	6412	70	859
15 :	3641	97	285	8597	41	036
16 :	8597	41	036	3641	97	285
17 :	0364	59	128	2859	64	703
18 :	2859	64	703	0364	59	128
19 :	7036	85	412	1285	36	970
20 :	1285	36	970	7036	85	412

Appendix B : Raw inspection time data for all 20 subjects for both sessions

	SUBJECT	S1N2	S1N4	S1D2	S1D4	S2N2	S2N4	S2D2	S2D4	
1	1	~~23.4~~	~~48.4~~	~~33.4~~	~~55.1~~	~~15.0~~	~~20.0~~	~~20.0~~	~~20.0~~	X
2	2	21.7	18.4	18.4	15.0	18.4	25.6	16.7	21.7	
3	3	28.4	36.7	30.1	43.4	26.7	30.1	28.4	43.4	
4	4	46.8	40.1	63.5	53.4	38.4	36.7	56.8	40.1	
5	5	41.8	31.7	43.4	30.1	25.6	30.1	23.4	43.4	
6	6	28.4	26.7	25.6	36.7	15.0	18.4	23.4	25.6	
7	7	16.7	18.4	20.0	25.6	21.7	23.4	31.7	23.4	
8	8	20.0	21.7	26.7	43.4	18.4	20.0	25.6	30.1	
9	9	76.8	55.1	43.4	45.1	35.1	46.8	68.5	61.8	
10	10	15.0	21.7	30.1	25.6	23.4	23.4	20.0	80.2	
11	11	~~66.8~~	~~111.9~~	~~30.1~~	~~28.4~~	~~28.4~~	~~48.4~~	~~53.4~~	~~41.8~~	X
12	12	30.1	28.4	41.8	41.8	21.7	16.7	28.4	38.4	
13	13	~~33.4~~	~~31.7~~	~~172.0~~	~~130.3~~	~~23.4~~	~~30.1~~	~~36.7~~	~~65.1~~	X
14	14	25.6	46.8	68.5	61.8	25.6	26.7	41.8	40.1	
15	15	15.0	26.7	25.6	41.8	21.7	16.7	21.7	23.4	
16	16	30.1	21.7	51.8	66.8	18.4	15.0	31.7	33.4	
17	17	21.7	21.7	25.6	36.7	21.7	18.4	28.4	28.4	
18	18	20.0	16.7	26.7	23.4	20.0	21.7	25.6	26.7	
19	19	23.4	20.0	40.1	31.7	15.0	15.0	18.4	23.4	
20	20	31.7	30.1	40.1	38.4	15.0	23.4	25.6	35.1	

where S1 = session 1
S2 = session 2
N2/N4 = normal quality, 2- or 4-member positive set
D2/D4 = degraded quality, 2- or 4-member positive set

Appendix C(i) : Raw reaction time data (msecs) for the 17 acceptable subjects for session 1

	SUBJECT	RS1N2Y	RS1N2N	RS1N4Y	RS1N4N	RS1D2Y	RS1D2N	RS1D4Y	RS1D4N
1	1	426	512	514	555	402	489	438	492
2	2	479	537	538	557	555	586	566	644
3	3	574	609	673	759	595	665	699	858
4	4	489	523	627	620	490	523	651	661
5	5	517	534	616	600	538	542	653	614
6	6	439	491	476	526	477	576	480	546
7	7	589	604	804	955	558	655	782	931
8	8	542	605	691	673	610	690	712	742
9	9	443	552	555	750	447	562	534	610
10	10	500	589	629	709	539	593	635	658
11	11	480	541	549	645	454	576	562	607
12	12	568	615	597	639	602	672	728	712
13	13	399	453	457	496	433	451	462	500
14	14	612	645	643	659	552	713	715	729
15	15	392	475	474	530	428	488	507	516
16	16	559	617	648	774	592	688	724	703
17	17	408	508	429	496	430	510	450	516

where RS1 = reaction time, session 1
N2/D2 = normal/degraded quality, 2-member positive set
N4/D4 = normal/degraded quality, 4-member positive set
Y/N = 'yes' response required/'no' response required

Appendix C(ii) : Raw reaction time data (msecs) for the 17 acceptable subjects for session 2

	SUBJECT	RS2N2Y	RS2N2N	RS2N4Y	RS2N4N	RS2D2Y	RS2D2N	RS2D4Y	RS2D4N
1	1	437	463	448	479	384	472	458	490
2	2	396	517	627	617	479	523	639	645
3	3	500	694	679	800	588	722	689	798
4	4	607	503	576	525	540	529	600	558
5	5	482	503	506	490	494	497	683	697
6	6	445	488	472	491	465	493	536	534
7	7	598	640	524	637	521	587	526	614
8	8	530	590	632	680	603	629	671	721
9	9	409	472	451	524	444	495	465	582
10	10	484	550	584	725	467	527	716	734
11	11	407	503	444	507	421	475	491	562
12	12	495	621	663	694	526	620	572	656
13	13	395	448	419	457	415	463	412	484
14	14	516	539	625	707	582	627	643	752
15	15	418	484	470	510	447	477	504	542
16	16	555	584	552	594	506	516	582	600
17	17	378	434	441	456	395	447	457	521

where RS2 = reaction time, session 2
N2/D2 = normal/degraded quality, 2-member positive set
N4/D4 = normal/degraded quality, 4-member positive set
Y/N = 'yes' response required/'no' response required

Appendix D (i) : Raw number correct out of 24 at zero exposure duration for session 1

	SUBJECT	S1N2Y	S1N2N	S1N4Y	S1N4N	S1D2Y	S1D2N	S1D4Y	S1D4N
1	1	11	11	17	15	15	9	13	9
2	2	19	14	11	8	15	17	13	12
3	3	20	9	16	8	17	6	14	9
4	4	6	15	8	10	9	14	7	10
5	5	5	15	6	20	7	21	4	15
6	6	10	13	16	10	17	9	17	10
7	7	11	18	23	7	10	11	19	3
8	8	17	13	15	12	12	14	10	13
9	9	10	13	15	12	16	10	15	11
10	10	14	16	19	9	13	9	16	8
11	11	11	12	14	9	16	6	14	7
12	12	7	20	15	10	5	17	9	9
13	13	3	21	8	19	11	20	10	16
14	14	1	22	5	20	3	22	4	21
15	15	15	10	12	6	13	14	6	15
16	16	5	16	9	11	10	17	5	17
17	17	13	18	19	11	12	8	15	10

N2/D2 = normal/degraded quality, 2-member positive set
N4/D4 = normal/degraded quality, 4-member positive set
Y/N = 'yes' response required/'no' response required

Appendix D (ii) : Raw number correct out of 24 at zero exposure duration for session 2

	SUBJECT	S2N2Y	S2N2N	S2N4Y	S2N4N	S2D2Y	S2D2N	S2D4Y	S2D4N
1	1	8	13	8	10	10	12	16	13
2	2	9	15	13	10	9	11	18	11
3	3	20	16	18	12	11	14	13	8
4	4	7	13	5	20	8	17	3	20
5	5	6	17	10	17	2	17	9	13
6	6	7	14	16	11	8	11	14	8
7	7	14	6	15	9	12	9	18	8
8	8	11	9	16	8	10	14	11	6
9	9	7	13	10	15	11	14	13	7
10	10	16	12	11	10	17	9	15	7
11	11	6	16	16	10	10	12	17	14
12	12	12	15	10	13	12	11	13	10
13	13	16	13	14	7	11	7	15	5
14	14	3	21	0	23	3	19	0	22
15	15	13	16	9	14	10	16	9	10
16	16	10	13	8	16	11	16	9	13
17	17	13	10	9	12	8	9	12	10

N2/D2 = normal/degraded quality, 2-member positive set
N4/D4 = normal/degraded quality, 4-member positive set
Y/N = 'yes' response required/'no' response required

Appendix E : Basic statistics for the number correct out of 24 at zero exposure duration data

css/pc: basic stats	Descriptive statistics in dbl precision N. of CASES = 17 (MD pairwise deleted)					
	N	Min	Max	Mean	Std.Err.	Std.Dev.
YIS1N2Y	17	1.000000	20.00000	10.47059	1.334270	5.501337
YIS1N2N	17	9.000000	22.00000	15.05882	.917440	3.782701
YIS1N4Y	17	5.000000	23.00000	13.41177	1.212856	5.000735
YIS1N4N	17	6.000000	20.00000	11.58823	1.064324	4.388320
YIS1D2Y	17	3.000000	17.00000	11.82353	1.004531	4.141788
YIS1D2N	17	6.000000	22.00000	13.17647	1.255093	5.174883
YIS1D4Y	17	4.000000	19.00000	11.23529	1.155325	4.763526
YIS1D4N	17	3.000000	21.00000	11.47059	1.047117	4.317372
YIS2N2Y	17	3.000000	20.00000	10.47059	1.085051	4.473780
YIS2N2N	17	6.000000	21.00000	13.64706	.822215	3.390080
YIS2N4Y	17	.000000	18.00000	11.05882	1.116292	4.602589
YIS2N4N	17	7.000000	23.00000	12.76471	1.045049	4.308849
YIS2D2Y	17	2.000000	17.00000	9.58823	.822741	3.392249
YIS2D2N	17	7.000000	19.00000	12.82353	.827982	3.413856
YIS2D4Y	17	.000000	18.00000	12.05882	1.198868	4.943058
YIS2D4N	17	5.000000	22.00000	10.88235	1.127472	4.648687