Notes, Comments, and New Findings

Semantic Categorization and High-Speed Scanning

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Two experiments used versions of Sternberg's item-recognition task, in which the subject could make a decision by semantic categorization or by a search of short-term memory. When a single category distinguished the words of a memory set from foils, pronounced deviations from a linear set-size effect were observed. Decision times were affected little by increases in set size beyond three or four, suggesting that a categorization process was circumventing an item-by-item search of memory. These results were observed in the absence of a consistent mapping between stimuli and responses; in other words, within a session the relevant category constant changed and stimulus words were used as both targets and foils. The results are compatible with a race model in which memory scanning and semantic categorization occur in parallel; the decision time is determined by the process reaching completion first.

Sternberg (1966) reported that a decision based on a search of memory produced decision times that increased linearly with the number of items to be searched. For small memory loads, this set-size effect has proven remarkably robust across a variety of item types, including letters (Nickerson, 1966), digits (Sternberg, 1966), words (Smith, 1967), and random forms (Sternberg, 1969). Sternberg concluded that subjects serially scan through the items of short-term memory (STM).

Experiments demonstrating this linear set-size effect use an item-recognition paradigm. In this paradigm, the subject commits a small set of items (usually six or fewer) to memory and must then make a speeded yes/no response regarding the presence or absence of a test item in this set. Targets and foils are commonly all of the same item type, and no feature reliably distinguishes them. In the absence of such a feature, subjects are forced to base their decision on a search of STM.

In experiments in which one or more features do distinguish targets and foils, there is often a substantially reduced and sometimes curvilinear relationship between decision time and set size.

This effect was observed by Ellis and Chase (1971) at the perceptual level when foil letters were distinguished from targets by the features of size or color. A letter/digit categorical distinction has been used to similar advantage in the item-recognition task (Lively & Sanford, 1972; Simpson, 1972). In an extension of the item-recognition task, Schneider and Shiffrin (1977) observed almost no effect for set size when targets and foils were separated by the letter/digit distinction. Semantic categorical membership can also apparently facilitate the rejection of foil words (Okada & Burrows, 1973; Reynolds & Goldstein, 1974).

These experiments suggest that decisions are sometimes made on the basis of a categorization process that is relatively unaffected by set size. Such a process would be increasingly likely to be completed before an item-by-item search as set size increases, resulting in the often observed curvilinear relationship between decision time and set size. However, the design in each of the above-mentioned experiments creates a form of response consistency. In all of these experiments, for example, a proportion of the foils are drawn from a categorically defined set and are never used as targets. Schneider and Shiffrin (1977) argued that response consistency permits the development of an automatic detection response that is unaffected by set size. The development of automatic detection is speeded by a target/foil distinction but does not depend on it.

The present study investigated the effects of semantic target/foil distinctions in the absence of response consistency. A central question con-
cerned the extent to which a categorization process could replace the scanning process as a basis for decisions. Given the speeds with which scanning can take place (much less than 1 sec for sets of fewer than six words), such a replacement would demonstrate a very rapid encoding and utilization of semantic information.

Experiment 1

Method

Materials and design. Memory sets, targets, and foils were all drawn from a stimulus set consisting of six exemplars from each of six categories: units of time, four-legged animals, colors, parts of the human body, articles of clothing, and musical instruments (see Table 1). The words were the most common members of their respective categories, as determined by the Battig and Montague (1969) word norms with the following restrictions: (a) Each word was three to eight letters in length. (b) No more than two words of a category began with the same letter. (c) No word belonged to more than one category of the Battig and Montague norms (e.g., orange). (d) No pairs of words were graphemically or phonemically confusable (e.g., mouth and mouse).

A usable target/foil distinction was established through a manipulation of memory-set type. For sets of multicategory set type, each item represented a different category; in single-category sets all items came from the same category. The factors of set size, test period, and response type were crossed with the factor of set type in a within-subjects design. The size of a memory set ranged from one to six words; an experimental session consisted of six test periods. Within a test period, each of 12 memory sets was tested in a block of 6 targets and 6 foils. The 12 memory sets represented each combination of set size by set type. Each single-category set was randomly selected such that no two sets of a test period came from the same category. Multicategory sets were similarly selected so that no group of words occurred in more than one set.

Within a test block, each of three foils was presented twice. The number of presentations for a memory-set item was in proportion to the set size (approximately, six divided by the set size). Each foil in a test block came from a different category, for single-category sets, none of these categories matched the category of the memory set. Each stimulus word had an equal chance of appearing in any combination of set type by response type within a test period. In an experimental session a word's use as a foil always roughly equaled its use as a target.

Apparatus. The experiment was run on a PDP 11/34 computer using the RSX-11M system. All stimuli were displayed in uppercase letters on a Beehive 100 terminal using a 5 × 7 (per character) dot matrix. The terminal was modified to display stimuli only at the beginning of a video frame; all stimulus-dependent timing was initiated at the beginning of a frame. Yes/no responses were made through a hand-held, two-button box. The left button was labeled "no" and the right button was labeled "yes."

Subjects and procedure. Seven male and six female subjects between the ages of 18 and 26 participated in a single 2-hr. session and were paid between $5 and $8 for their participation. A game format was used in which subjects were awarded points for fast errorless performance; these points were converted into money at the end of the experimental session. Subjects earned a half point for each decision time faster than a "time to beat" (discussed later), and subjects lost two points for each error.

The subjects became familiar with the words and categories through three initial tasks. In an old/new recognition task, each word of the stimulus array was presented twice in a random order and subjects made the appropriate speeded response. In a spelling task, each word was presented for 1 sec, after which the subjects were required to correctly spell the word. A spelling mistake initiated an immediate re-presentation of the word. In an STM span task, the six exemplars of a category were presented, in succession, at 1-sec intervals, and the subject attempted to recall the words in any order. Less than perfect recall brought about an immediate re-presentation of the exemplars in a new order. Each category was tested to a criterion of one perfect recall. The exemplars of the category were scrambled in this manner; the subjects were required to type in a name for the category.

The instructions preceding the item-recall task (a) informed subjects that a categorization between targets and foils would occur, and (b) encouraged them to remember the name of this distinction. Two practice test blocks preceded each test period. These blocks gave the opportunity to win bonus points, and the subject's average decision time within the test period was determined from the initial time to beat. Before the remaining test blocks in a period, the time to beat was set equal to the smaller of two times: (a) the previous time to beat multiplied by 1.5, or (b) the average of the previous block and the actual mean decision time of the previous block. This number was then multiplied by point values and added to the fac tor of 0.5. Each test block began with a screen displaying the memory set presented in a randomized column, and (b) the time to beat. The subject viewed the display for as long as he wished and then pressed the "return" button on the terminal. The monitor terminated the display and initiated only ordered presentation of the test items. The display of each test item, timed for 1 sec, was then presented on the screen, following by a delay. The screen then cleared, the subject then pressed the button of the response box. A press of the no-response button terminated the display and the time to beat. At the end of the test block, the subject was informed of his average decision time, number of times they were faster than the time to beat, their error rate, their points, and their new point total.

Within a test period, memory sets were randomized with respect to set size. After every other test period, subjects performed a span task and were then given feedback. The span task's primary purpose was to yield the test's of the item-recognition and item-position performance. Results are reported here.

Results

Decision times and error rates were analyzed by a 3 × 2 × 2 × 3 within-subjects analysis of variance. Decision times were recorded for trials in which an error was made, and the times themselves exceed 1 sec. Less correct responses were found to be less time efficient than incorrect responses. The figure shows the relationship between the factors of stimulus duration, set size, and response type. With respect to decision time, main e
The number of presentations for each category set was six, divided by the set size. Each test block came from a different category set, none of these categories being the category of the memory set. Each word had an equal chance of appearing in any combination of set type by response type for each test period. In an experimental session, a foil word was always placed equally as a foil, with no words being used as foils at any point in the experiment.

The experiment was run on a PDP computer using the RIS-11M system. Items were displayed in uppercase letters on a 100 terminal using a 5 x 7 (per character) matrix. The terminal was modified to enable stimuli only at the beginning of a trial. All stimulus-dependent timing was included in the beginning of a frame. Yes/no responses were made through a hand-held, two-button device. The light button was labeled “no” and the dark button was labeled “yes.”

Subjects and procedure. Seven male and six female subjects between the ages of 18 and 22 participated in a single 2-hr. session and were paid $5 and $5 for their participation. A game was used in which subjects were rewarded for fast, errorless performance; these points were converted into money at the end of the experimental session. Subjects earned a half-point decision time faster than a “time to beat” decision, and subjects lost two points for errors.

Subjects became familiar with the word categories through three initial tasks. In an item recognition task, each word of the stimulus was presented twice in a random order. Each word was the appropriate speeded response in a spelling task, each word was presented for 1 sec, after which the subjects were to correctly spell the word. A spelling task followed an immediate re-presentation of each word. In an STM span task, the six exemplars were presented, in succession, at 1-s intervals, and the subject attempted to recall each word.

The number of presentations for each category set was six, divided by the set size. Each test block came from a different category set, none of these categories being the category of the memory set. Each word had an equal chance of appearing in any combination of set type by response type for each test period. In an experimental session, a foil word was always placed equally as a foil, with no words being used as foils at any point in the experiment.

Each test block began with a screen display of the memory set presented in a randomly ordered column, and the time to beat. Subjects viewed the display for as long as they wished. A press of the “return” button on the terminal keyboard terminated the display and initiated a randomly ordered presentation of the test items. Preceding the display of each test item, the word ready appeared on the screen, followed by a 300-msec delay. The screen then cleared, a test item appeared, and the timer began. A press of the yes or no response button terminated the display and stopped the timer. At the end of a test block, subjects were informed of their average decision time, the number of times they were faster than the time to beat, their error rate, their points earned, and their new point total.

Within a test period, memory sets were presented randomly with respect to set size and set type. After every other test period, subjects performed a span task and were then given a 3-min. break. The span task’s primary purpose was to break the tedium of the item-recognition task, and span-task results are not reported here.

Results

Decision times and error rates were submitted to an analysis of variance. Decision times were discarded for trials in which an error was made or the item itself exceeded 1 sec. Less than 1% of the correct responses were longer than 1 sec. Figure 1 shows the relationship between performance and set size for the four combinations of set type and response type.

With respect to decision time, main effects indicating the advantages of single-category sets, targets, and practice (across test periods) were all significant (p < .01). In addition, there was a set-size effect, F(5, 60) = 114.00, p < .001. However, there was no interaction between set size and set type, F(5, 60) = 22.63, p < .001. The linear component accounts for 56% of the variance in the single-category condition and for 35.8% of the variance in the single-category condition.

The departure from linearity for the single-category condition can be attributed to an apparent lack of any effect when set size was increased beyond three words. The mean time for a correct yes response in the single-category condition was 473 msec for three-item sets and 475 msec for six-item sets. The mean times for a correct no response were 525 msec and 521 msec for these same two set sizes, respectively.

In the accuracy data, the main effects of set size and response type were both significant (p < .02). In agreement with the decision-time results, there was a marginally significant interaction between set size and set type, F(5, 60) = 1.95, p < .10. There is no indication, then, that the decision-time results can be explained as a simple speed/accuracy trade-off. The overall error rate was 5.3%.
Table 2
Stimulus Words Used to Extend the Stimulus Set for Experiment 2

<table>
<thead>
<tr>
<th>MONTH</th>
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<td>DAY</td>
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<td>MULE</td>
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**Discussion**

A categorical distinction, in the absence of response consistency, has a clear-cut and dramatic effect on performance in the item-recognition task. The curvilinear relationship between decision time and set size for single-category sets strongly implies a categorization process, which is unaffected by set size.

Ellis and Chase (1971) proposed that categorization at a perceptual level and scanning could take place in parallel, with decision times reflecting the faster to complete of the two processes. In tasks requiring a dual judgment for each item of the memory set, Burrows and Okada (1973, 1976) and Paieff (1977) found evidence that semantic information can also be retrieved in parallel with a serial scan.

Categorization and scanning, however, need not take place in parallel to account for the data. Another possible model uses a probabilistic mixture of categorization and scanning (e.g., Atkinson, Herrmann, & Wescourt, 1974). In such a model, the probability that categorization is first attempted for single-category sets of three or more items would have to be near 100% to account for the present results. In fact, subjects in the experiment could have made a strategic commitment to categorization at the beginning of a single-category test block. If they chose to make their decisions on a categorical basis, there would have been no need to even maintain the individual set items in memory, since categorization alone would always have provided the correct response.

The second experiment made such an a priori commitment to categorization impossible. The experiment tested single-category sets in a test block containing an equal number of related foils (same category) and unrelated foils (different categories). Since presentation order for the two foil types was random, the subject would always have to keep the memory set active in order to distinguish targets from related foils. However, it would be possible to reject unrelated foils by means of a category judgment. Of particular interest is the interaction between scanning and categorization in a task where the majority of test items in a block require a serial scan.

**Method**

**Materials and design.** All items of a memory set were drawn from the same semantic category. The factor of foil relatedness replaced the set-type manipulation of Experiment 1. Three foils in a test block were categorically related to the items of the memory set, and the remaining three foils were unrelated. The use of related foils with larger memory sets required an increase in the number of exemplars per category; this was accomplished by adding the words shown in Table 2.

As in the previous experiment, there were six test periods with 12 blocks each. Within a test period, two memory sets of different size were randomly selected from each of the six categories. Three related foils were randomly drawn from the words remaining in a category after a set's selection. The three unrelated foils were randomly drawn from a random collection of three of the five remaining categories. Within an experimental session, each word had an equal chance of appearing as a target and a foil. In addition, each word had an equal chance of appearing as a related and unrelated foil.

**Subjects and procedure.** Seven male and eight female subjects from the same population used in Experiment 1 participated in a single 2-hr. session and were paid between $5 and $8 for their participation. The familiarization tasks again preceded the item-recognition task. In the span-familiarization task, the word sequence length was reduced from six to five, and each category in Table 2 was tested twice to insure that each word was included in at least one span sequence.

In the instructions preceding the item-recognition task, subjects were encouraged to use category information in the rejection of unrelated foils. In all other respects, experimental procedure and design followed that of Experiment 1.

**Results**

Figure 2 shows the relationship between performance and set size for the three test-item types (targets, related foils, and unrelated foils). Decision times were screened using the procedure described for Experiment 1. Again, fewer than 1% of the correct responses exceeded 1 sec. for three subjects were excluded from the analysis, because of an error rate exceeding 10%. The rate analysis of the data for these three produced complete agreement with the results from the remaining subjects, which follow.

An analysis of the decision times revealed that significant effects of practice (across rows) and set size (p < .001). Unrelated foils were rejected significantly faster than related foils, F(1, 11) = 22.97, p < .001. In order to understand the interaction, the two foil conditions were considered in relation to targets. The effect was significantly less for unrelated foils than for targets, F(3, 33) = 16.95, p < .01. The other hand, the effect of set size was significantly greater for related foils than it was for unrelated foils, F(3, 33) = 3.67, p < .01. The interaction of the relationship between set size and decision time accounted for 98.9% of the variance in related foils and 91.7% of the variance in unrelated foils. The quadratic component accounted for less than 1% of the variance in related foils and for 7.9% of the variance in unrelated foils. For targets, the linear component accounted for 92.3% of the variance and the quadratic component accounted for 61.1% of the variance in related foils. These figures for targets are in close agreement with the corresponding figures for the categorization condition of Experiment 1.

**Conclusion**

Although most of the trials in a test block were related, the categorization continued to facilitate the rejection of unrelated foils, especially at the larger set sizes. The decrease in decision time as set size ran...
Experiment 2

**Materials and design.** All items of a memory set were drawn from the same semantic category, and of the foil sets related to the items in the memory set, and the remaining three foils were used for each subject. Three foils in a set were categorized in relation to the items in the memory set, and the remaining three foils were categorized as unrelated foils. The use of related foils with larger sets required an increase in the number of foils per category; this was accomplished by the words shown in Table 2. In the previous experiment, there were six foils with 12 blanks each. Within a test trial, each foils of different size were selected from each of the six categories, unrelated foils were randomly drawn from the remaining in a category after a set's selection: three unrelated foils were randomly drawn from a random collection of three of the items in that category. Within an experimental task, each word had an equal chance of appearing as a target and a foil. In addition, each item had an equal chance of appearing as a target or as an unrelated foil.

**Subjects and procedure.** Seven male and eight female subjects from the same population used in Experiment 1 participated in a single 2-hr. session paid between $5 and $8 for each hour of participation. The familiarization tasks again preceded the item-recognition task. In the span-fusion task, the word sequence length was reduced from six to five, and each category in the test was twice as long to ensure that each word appeared at least once in each sequence. A list of instructions preceded the item-recognition task, subjects were encouraged to use categorization in the rejection of unrelated items. All other respects, experimental procedure followed that of Experiment 1.

Figure 2 shows the relationship between period set size for the three test-item types (related foils, and unrelated foils). Data were screened using the procedure for Experiment 1. Again, fewer than 1% of the correct responses exceeded 1 sec. The data for three subjects were excluded from the analysis because of an error rate exceeding 10%. (A separate analysis of the data for these three subjects produced complete agreement with the results from the remaining subjects, which follow.)

An analysis of the decision times revealed significant main effects of practice (across test periods) and set size ($p < .001$). Unrelated foils were rejected significantly faster than related foils were, $F(1, 11) = 130.43, p < .001$. The differential effect of set size on the three test-item types is reflected in a significant interaction, $F(10, 110) = 22.97, p < .001$. To understand this interaction, the two foil conditions were separately considered in relation to targets. The effect of set size was significantly less for unrelated foils than it was for targets, $F(5, 55) = 16.95, p < .001$. On the other hand, the effect of set size was significantly greater for related foils than it was for targets, $F(5, 55) = 3.57, p < .01$. The linear component of the relationship between set size and decision time accounted for 98.9% of the variance for related foils and 91.7% of the variance for unrelated foils. The quadratic component accounted for less than 1% of the variance for related foils and for 7.9% of the variance for unrelated foils. For targets, the linear component accounted for 92.3% of the variance and the quadratic component accounted for 6.1% of the variance. These figures for targets are in close agreement with the corresponding figures for the multicategory condition of Experiment 1.

In the error data, a main effect for set size was significant, $F(5, 55) = 15.13, p < .001$. The decision-time advantage for unrelated over related foils was reflected in error rates as well, $F(1, 11) = 13.24, p < .004$. Set size had a significantly greater impact on error rates for related foils than for targets, $F(5, 55) = 5.48, p < .001$. There was no significant interaction in the relationship between set size and targets versus unrelated foils ($p > .17$). However, error rates for targets were significantly greater than for unrelated foils, $F(1, 11) = 46.75, p < .001$. The error rates for unrelated foils were by far the lowest of the three conditions and were obviously unaffected by increases in set size. There is no indication that decision-time differences are solely the result of a speed/accuracy trade-off.

**Discussion**

Although most of the trials in a test block required a memory scan, the categorization process continued to facilitate the rejection of unrelated foils, especially at the larger set sizes. The total increase in decision time as set size ranged from four to six was only 15 msec for unrelated foils, in comparison to a 74-msec increase for related foils and a 44-msec increase for targets. The average time to reject an unrelated foil at these larger set sizes is virtually identical to the rejection time for single-category foils in Experiment 1 ($528$ vs. $529$ msec). The greater linearity of the decision-time slope may indicate that decisions for unrelated foils were sometimes based on a serial scan for even the larger set sizes.

Both the decision-time and error-rate slopes are significantly steeper for related foils than for targets, suggesting that the category membership of a foil may impede as well as facilitate its rejection. This is further indicated by a comparison of Experiments 1 and 2, in which differences in performance are noticeable for sets of five and six items. For these set sizes, targets in Experiment 2 are about 12 msec faster than multicategory targets in Experiment 1. In contrast, related foils in Experiment 2 are about 24 msec slower than multicategory foils in Experiment 1. In addition,

1. If the decision-time slope for related foils is depressed as a result of a speed/accuracy trade-off (a possibility suggested by the high error rates for related foils), then the slope may actually be in a 2:1 relationship with the decision-time slope for targets. Therefore, subjects may have used a terminating search to distinguish targets from related foils. However, it is not clear why a terminating search would selectively produce such high error rates for related foils.
error rates are considerably higher for related foils at the larger set sizes. Poor performance for related foils could occur in a parallel model as the result of a response competition between the categorization process and scanning. It is likely that a suppression of the category yes response would take extra time; a failure to suppress this response would lead to an error.

General Discussion

The results of these two experiments are perhaps best described in terms of a parallel race model involving serial scanning and the categorization process. Categorization dominated for sets of more than three or four items and was unaffected by changes in set size. These effects were observed in the absence of a consistent mapping between stimuli and responses. In both experiments the relevant category changed after every 12 trials, and stimulus words were used equally often as targets and foils.

The results demonstrate a use of semantic information to circumvent an item-by-item search of memory. Similar results have been obtained in the fast-retrieval paradigm of long-term memory (McCloskey & Bigler, 1980; Reder & Anderson, 1980; Smith, Adams, & Schorr, 1978). In the experiments of Reder and Anderson, for example, interference did not occur among a set of semantically related facts when foils were semantically unrelated. Interference returned, however, when semantically related foils were used.

References


Received February 24, 1981
Revision received October 8, 1981

In the last decade there has been a trend of interest in the processes involved in spatial reasoning. Much of this interest has focused on studies of the “mental rotation” problem by Shepard and his colleagues (e.g., Shepard, 1975; Metzler & Shepard, 1975; Shepard & Metzler, 1975) in a variety of related tasks, chronometrically supported a powerful process model of how humans manipulate spatial information. The tasks have generally dealt with judged figures psychomotorically, and the mental rotator proposes that humans holistically rotate features in an analog fashion.

In the current experiments, adult spanning was examined across a wider range of tasks than has typically been studied. The mental rotation problem was compared using object arrays and questioning procedures. In the first type (directly akin to those studied by Shepard) 5 subjects predicted the outcome of a rota relative to a stationary viewer (rotation problem). In the second problem, they predicted the outcome of a rotation of the subject's body (rotation problem).

These array-rotation and viewer-rotation conditions were contrasted for three types of procedure that proved different aspects of spatial information. The three types were termed appearance, item
Interaction between water and melt in the system CaO-\(\text{SiO}_2\)-\(H_2O\)

**Abstract**

Interaction between water and melt in the system CaO-\(\text{SiO}_2\)-\(H_2O\)
2. Experimental methods

The method of measurement of the light scattering by the test solutions is based on the principle that the scattering intensity is proportional to the concentration of the solute. The scattering intensity is measured using a spectrophotometer, which records the light intensity at different wavelengths. The measurements are performed at controlled temperature and pH, to ensure consistency.

The solutions are prepared by dissolving the solute in water or buffer solutions, at concentrations ranging from 0.1 to 1.0 mol/L. The solutions are then allowed to equilibrate for at least 24 hours before measurement.

The scattering intensity is measured at wavelengths of 400, 500, and 600 nm, and the results are plotted on a graph. The graph shows a linear relationship between the scattering intensity and the concentration of the solute, which is used to determine the concentration of the solute in the sample.

The experimental setup includes a light source, a sample cell, a spectrophotometer, and a data acquisition system. The data is analyzed using statistical software to determine the concentration of the solute in the sample.

The results are compared with the theoretical predictions to validate the experimental method. The experimental results show good agreement with the theoretical predictions, indicating that the method is reliable and accurate.

The limitations of the method include the potential for errors due to the presence of impurities in the solution and the possibility of light scattering by other particles in the solution. However, the experimental results indicate that these limitations are minimal.

The method of measurement is considered to be a reliable and accurate method for determining the concentration of solutes in solution. It is widely used in various fields, including chemistry, biology, and environmental science, for measuring the concentration of substances in solution.
The spectrum of $\text{SiO}_2$ shows two prominent bands. The first band is located around 1080 cm$^{-1}$ and is attributed to the symmetric stretching vibration of the Si-O-Si bond. The second band is observed at 790 cm$^{-1}$ and is assigned to the asymmetric stretching vibration of the Si-O-Si bond. These vibrations are characteristic of the Si-O-Si framework in silicate minerals and are crucial for understanding the structural properties of these materials.

The absorption features in the spectrum of $\text{SiO}_2$ can be modeled using a simple harmonic oscillator model. The frequency of the harmonic oscillator is given by $\nu = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$, where $k$ is the force constant and $m$ is the mass. In the case of the Si-O-Si bond, the force constant $k$ is related to the bonding strength and the mass $m$ is related to the electron density.

The intensity of the absorption bands can be calculated using the following expression:

$$I = \frac{1}{\pi \nu^2} \left( 1 + \frac{\nu^2}{\nu_0^2} \right) \left( \frac{\nu}{\nu_0} \right)^2 \left( 1 + \frac{\nu^2}{\nu_0^2} \right)^{-\frac{3}{2}}$$

where $\nu_0$ is the resonance frequency of the oscillator. This expression describes the Lorenzian lineshapes of the absorption bands in the spectrum of $\text{SiO}_2$.
In order to determine the relative importance
and dependence of H2O, NaOH, and K2CO3 in the reaction
between Na2O2 and CO2, the following equation was
employed:

$$\text{Na}_2\text{CO}_3 + \text{H}_2\text{O} \rightarrow \text{Na}_2\text{HCO}_3 + \text{NaOH}$$

The results showed that NaOH has the greatest
influence, followed by K2CO3 and H2O. The
concentration of NaOH in the reaction mixture
was found to be critical for the formation of
bicarbonate. When the concentration of NaOH was
increased, the amount of bicarbonate produced also
increased. However, when the concentration of NaOH
was decreased, the bicarbonate yield decreased
significantly.

$$\text{Na}_2\text{CO}_3 + \text{H}_2\text{O} \rightarrow \text{Na}_2\text{HCO}_3 + \text{NaOH}$$

The reaction was further studied by varying the
concentration of NaOH and observing the effect on the
bicarbonate yield. It was observed that the optimal
concentration range for NaOH was between 0.1 M and
0.2 M. Outside of this range, the yield of bicarbonate
was significantly reduced.

In conclusion, NaOH is the most important factor
in the reaction between Na2O2 and CO2, followed by
K2CO3 and then H2O. The concentration of NaOH
plays a crucial role in determining the yield of
bicarbonate.