increasing age and their presumably less sensitivity to sexual odors, especially those laid down in linear apparatuses. On the other hand, there has been some suggestion in data collected in this laboratory that males are also more sensitive to variations in sucrose concentration (or at least that they are more attracted by higher concentrations). Thus, while the choice of one sex or the other should of course be made in accordance with the particular requirements of the experiment, it is reassuring that use of female rats is not generally contra-indicated for instrumental appetitive learning on the basis of their estrous cycle.

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NOTE

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A measure of pronounciability of CVC trigrams¹

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All 2100 CVC trigrams were scaled for pronounciability by measuring pronunciation latency (P Lat). The resulting distribution of P Lat scores was extremely leptokurtic and positively skewed. Scores ranged from a minimum of .531 sec to a maximum of 1.726 sec. Average P Lat was .81 sec. The relationship of P Lat to Archer meaningfulness was linear; however, the degree of relationship was slight ($r = -.37$). This finding is interpreted as indicating that P Lat is relatively free of bias from such other stimulus attributes as meaningfulness. As such, P Lat is viewed as reflecting a basic processing time for such stimulus materials.

The demonstrated potency of meaningfulness in verbal learning has been amply attested to in several reviews (e.g., Goss & Nodine, 1965; Underwood & Schulz, 1960). One of the important underlying dimensions of meaningfulness is pronounciability. Several studies have reported high positive correlations between rated pronounciability and rated meaningfulness (e.g., Underwood & Schulz, 1960; Wilson & Becknell, 1961). Recently, Gorfain (1967) used pronunciation latency (P Lat) as a measure of pronounciability. Using 144 CVCs from Underwood and Schulz's list, Gorfain obtained an r of $-.66$ between P Lat and rated meaningfulness. This correlation is lower than those reported with rated pronounciability, which led Gorfain to argue that these latter correlations are spuriously high due to significant commonality between ratings of pronounciability and meaningfulness.

One shortcoming of all of these studies, whether they use ratings or P Lat to measure pronounciability, is that they are limited to small subsets of CVC trigrams. This situation may present an unrepresentative picture of the relationship between pronounciability and meaningfulness. The present experiment corrects this situation by scaling the pronounciability of all 2100 CVC trigrams using P Lat as a measure thereof.

METHOD

Materials

All possible CVC trigram combinations were used except those containing duplication of consonants in initial and terminal positions (e.g., "BAB") and those containing "Y" as a vowel (e.g., "BYC"). An alphabetical listing of these 2100 trigrams was randomized by using the ordinal positions of each item as inputs in a computer program that generated new random ordinal positions for each item as outputs. The resulting random listing of CVCs was divided into four sublists of 525 items each.

Subjects

Forty Ss were randomly assigned to one of four sublists containing 525 trigrams each. The order of presentation for each sublist was constant for all Ss. The latter were undergraduates fulfilling course requirements in psychology. There were nine males and one female for each sublist. Each S was run individually and was read the following instructions:

"This is an experiment designed to see how people pronounce nonsense syllables. When the experiment begins, nonsense syllables will appear one at a time on the screen in front of you. I want you to try and pronounce each of these as carefully as possible. Each nonsense syllable will appear on the screen for 1 sec, or until you pronounce it. If you have not pronounced it within 1 sec, it will go off, but you will still have 2 sec to make a response before the next syllable appears. Try to be careful to give the *correct* pronunciation. Do you have any questions?"

After the instructions were read, the sensitivity of the voice key was adjusted to each individual by having S articulate pauses (e.g., ahh, err).

Apparatus and Procedure

Stimulus presentation and data collection were accomplished by means of a DDP-116 computer (Control Data Corporation) and auxilliary equipment that included oscilloscope, voice key, and microphone. The microphone was positioned 6 in. from S's

lips and held in place by a "chesty" microphone support.

The three letters of each trigram were displayed as 1-in. capitals on an oscilloscope. The S was seated approximately 2 ft in front of the display. As each trigram was presented, P Lat was obtained by measuring the time between onset of the stimulus and the initiation of S's pronunciation response, which activated the voice key. The measurements were computed to within 1/100 sec and punched out on paper tape.

An auxiliary oscilloscope and sound system was used by E to monitor Ss' pronunciation response and to check for extraneous sounds (e.g., coughs, laughs, sneezes, etc.) that would activate the voice key and result in erroneous times. Ss were disqualified from the experiment if their records contained more than 6% erroneous response (32/525 errors). Three additional Ss were disqualified on this basis. Each S was required to pronounce each of the 525 trigrams of a sublist twice. A self-paced format was used in order to obtain minimum times for pronunciation of each trigram. It was assumed that the P Lat scores obtained under the self-paced format would be influenced less by associative factors than those obtained under a constant rate.

A maximum of 3 sec response time was allowed for pronouncing each trigram. This time was variable depending on Ss' response latency, and was subdivided into a maximum display time of 1 sec followed by a maximum "off" time of 2 sec during which the display was dark but S could still respond. The initiation of a response by S at any point during the 3-sec period would activate the voice key and terminate the presentation sequence for that trigram. If S initiated a response during the display time, the presentation sequence was interrupted, and, after a brief pause (.25 sec), the presentation sequence was repeated with a new item. Under the self-paced format Display Time = MIN(1, P Lat) sec, and Response Time = MIN(3, P Lat) sec. For Display Time, MIN refers to the minimal value of either 1 sec or P Lat, whichever is less; for Response Time, it refers to 3 sec or P Lat, whichever is less.

Using this format, the average time required to pronounce all 525 items was 12.5 min. If the presentation rate had been constant at 3 sec per item, it would have taken over 26 min to pronounce all 525 items. After a brief rest period (2 min) the list was repeated (same order) and S was again required to pronounce each trigram. The average time to complete the task on the second repetition was 11 min.

RESULTS AND DISCUSSION

Distribution of Scores

P Lat represents mean latency based on the scores of 10 Ss.³ The P Lat scores for all 2100 CVC trigrams on Trial 1 only are presented in Fig. 1, which shows the frequency of P Lat values for successive .04-sec intervals from 0.531 sec to 1.725 sec. All CVCs with latencies falling within the .04-sec intervals are printed in a single column one above the other. The result is a frequency histogram with the 2100 trigrams filling the columns. As such, the histogram not only shows the overall shape of the latency distribution, but also presents the data in a way that allows one to select trigrams from any given latency range by simply referring to the column that spans the desired range of values.⁴ Within each column, latencies increase from bottom to top.

The P Lat values of trigrams in a given column are greater than the lower bound and less than or equal to the upper bound. Thus, the P Lat of a trigram can attain the upper bound of the column, but, with the exception of the first column, cannot attain the lower bound.

The average P Lat (overall) on Trial 1 was .81 sec with an SD of .27 sec. Latencies ranged from .53 to 1.72 sec. This range of latencies is considerably greater than that found by Gorfein using a subset of 144 CVC trigrams. Gorfein reported median

pronunciation latencies ranging from 1.54 to 2.04 sec. The P Lat scores of the present experiment for the same 144 items correlated +.47 with Gorfein's data. Procedural differences between the two experiments are undoubtedly responsible for the relatively low agreement between the two sets of data. Gorfein used a constant presentation rate. This procedural difference may also account for the discrepancies in range and absolute magnitude of P Lat scores between the two studies.

The distribution of P Lat is extremely leptokurtic and positively skewed as indicated by the fact that 95% of the trigrams fall within ± 1 SD. This finding can be taken as evidence that the nonsense syllable is truly a syllable (i.e., it is pronounceable). The fact that P Lat correlated only +.27 with Johnson's (1964) associative latency measure (169 items) suggests that associative factors played a minor role in the P Lat scores.

P Lat scores accumulated at the lower end of the distribution to suggest a lower limit to P Lat at .5 sec. This lower limit agrees with paired-associate experiments in which the anticipation interval was varied (e.g., Nodine, 1963, 1965). In these studies, it was found that Ss were unable to make an anticipation response under conditions in which the anticipation interval (stimulus duration) was .5 sec.

Because of the shape of the obtained distribution of P Lat, it is suggested that items be classified into three categories of pronounceability according to P Lat: (1) *Medium*—which includes items ranging from .686-.945 sec ($\pm .5$ SD). This range contains 1663 items or 79.2% of the distribution. (2) *High*—which includes items from .531-.675 sec. There are 197 items or 9.4% of the distribution in this range. Referring to Fig. 1, the last item in this range is GAP. (3) *Low*—which includes items from .946-1.726 sec. There are 240 items or 11.4% of the distribution in this range. Again referring to Fig. 1, the first item in this range is KAV.

Practice Effects

Because the order of presentation of each sublist was constant for all Ss, it was necessary to determine whether or not latencies increased from the first to last item in the sublist. Mean latencies for successive blocks of 15 items each were analyzed by analysis of variance. The resulting $F(35,1904) = 1.06$ was nonsignificant and it was concluded that P Lat was unaffected by practice effects.

Repetition Effects

Each S pronounced the 525 trigrams of a sublist twice. Average P Lat decreased from .81 to .76 sec on the second repetition, $F(1,36) = 2.97$, n.s. A modified split-half technique was used to obtain a measure of stability of P Lat. Each group of Ss received a different random sublist of the 2100 items. After arranging the latency scores for individual items in increasing order of magnitude for each sublist, correlations were performed on equivalent items between sublists. These six correlations ranged from $r = .94$ to $r = .98$, suggesting high intersubject agreement on equivalent items within the list. The procedure of correlating sublists after ranking the items from low to high provides a way of comparing the distribution of P Lat scores for different sublists. The extent to which the distributions of the sublists are similar is reflected by the magnitude of the correlations obtained.

Sublist Effects

Although Ss were randomly assigned to each of the four sublists, analysis of variance indicated that average P Lat scores for Sublist 2 were significantly faster than those for Sublists 1, 3, and 4, $F(3,56) = 6.73$, $p < .001$. While this difference was a reliable one, the magnitude of the average difference among sublists was relatively small (.07-.10 sec).

Fig. 1. Frequency histogram showing P Lat values for all 2100 CVC trigrams. P Lat values in a given column are greater than the lower bound and less than the upper bound. (This figure had to be split over four pages in order to be bound in the journal. But it should be read as though it is one continuous page beginning at the top of this page and running to the bottom of page 215.)

Figure 1 continued.

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. . . ZUM QAL ZEF FUC . . .
. . . MEL RAZ MES MON . . .
. . . WNP MEL NUJ QID . . .
. . . NOL ZAL NON KIR . . .
. . . VOL MOK CAS MOR . . .
. . . TAN FER POC XUB . . .
. . . SOX FAP SUF SEG . . .
. . . NOZ ZAK POW VIG . . .
. . . KUL RIB POB FUV . . .
. . . KUT QIT GOV WUR . . .
. . . QIX PUV BEQ YAG . . .
. . . BIC RIK GAV CIM . . .
. . . ZUD DAJ VOL COO . . .
. . . BEC DER BIV FIM . . .
. . . TAN GIY JAR NED . . .
. . . LAB KEL JOB VAM . . .
. . . MUV KUS MEV PUN . . .
. . . TUP MUT PAN BEY . . .
. . . LUS DOR HEM ZUV . . .
. . . BOD TAX MER BER . . .
. . . DIC JOL DEH FIY . . .
. . . ZOP ZOD SEC LIV . . .
. . . KAJ FAV FUS BOV . . .
. . . KEN JUX DOY ZAV . . .
. . . LIC DEP JEC PUZ . . .
. . . YOM MIM NOM ZUL . . .
. . . SAR DUC JIK FEK . . .
. . . LOS FOM KEF VOM . . .
. . . MEZ YEL VIP MAX . . .
. . . FAC MUN SUR GER . . .
. . . DAS XUS PIL NEW . . .
. . . NAK KAG CAM QOP . . .
. . . DUV SOZ FIM ZED . . .
. . . MAW QIF GIN ZUP . . .
. . . TEM ZIR YAP PIM . . .
. . . RAM MIK XAM WOY . . .
. . . VAO TOZ KIS JOP . . .
. . . SIM LUD JID KOT . . .
. . . YET PUM QIB GIL . . .
. . . BAL HEY GOK JOM . . .
. . . JEY CAX DEZ BIM . . .
. . . FOC WOB YEO VUY . . .
. . . PES GEM FIK QUP . . .
. . . ZUR DIP COF QIC . . .
. . . SUM FOT DOK BAV . . .
. . . ZIT YIN YED NAF . . .
. . . MUG VIK MAK YEJ . . .
. . . HAN JAW ROM WAV . . .
. . . HEX YUM TIJ RAO . . .
. . . LAK MUG VAZ YEK . . .
. . . DAN VOX VUC CIJ . . .
. . . RUY LUN MIT GAB . . .
. . . PAV FOG MUM QOC . . .
. . . FUL HED HOK MAG . . .
. . . MAG SEN TIL XAM . . .
. . . FUM FAS ROM COY . . .
. . . BUN YUD FUP SOO . . .
. . . WIF PAX KIM KON . . .
. . . JEX JEV SAP QEY . . .
. . . RAM MUQ NEK CIM . . .
. . . NIT CUR DOM CEN . . .
. . . KES BEZ QIG LIM . . .
. . . JOT PIS GAZ NOK . . .
. . . KOS DET MOY SID . . .
. . . TAL LAY LIP PUF . . .
. . . LEV BE4 POL JUV . . .
. . . VAX JAT RAK FIC . . .
. . . NUS MUT FAQ JIF . . .
. . . DAZ BE4 BEV DOO . . .
. . . HEF MOC KAX MIO . . .
. . . CEZ VAS MEB NES . . .
. . . PEL VEN YAR XUD VAF . . .
. . . JOB BOX OAC NEO PEM . . .
. . . YOP RIT MEK VAB MOD . . .
. . . YES PAT FEX WEJ XAJ . . .
. . . PTK SEP GUS LUV MUJ . . .
. . . KIP LUG JON DIJ XUV . . .
. . . RES ZI- YOJ PAC GOR . . .
. . . SUT TUJ FIM LEN QAD . . .
. . . FED TUC YAL ZUB TEC . . .
. . . HAJ KAC RAJ ZOS ZEX . . .
. . . SIX BES MIR BOK SIP . . .
. . . PEK DEN ROZ DIX KOT . . .
. . . JAN YEB CIT YTD BUG . . .
. . . YEP TEX JAB LAS DUV . . .
. . . RIS LON FUX MON NOM . . .

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(Continued on next page.)

Figure 1 continued.

TER NUC FEY FIG NAJ
 JUQ JEF VUN TIK JUM
 DOJ WEN ZOX TIM QUT
 MAX DUL SER DEK MAB
 LEM LIT VEM PIO SIT CEY
 LOF SEM BEJ LOR GIM QIS
 SUR YEC YAT ROQ TID POF
 MIZ FOR BUN GUM VIY NOJ
 MOG LAN LOZ WEZ PIJ VUZ
 HAM YAW FEP COK NEZ CIN
 NUF SEL OUR COW M19 XAN
 JAD WEG DUG SON SUY NUH
 DAO GOF HOL CAR ZAN QIP
 BAS JIT WIK LUG GOY YIJ
 DAW YIS KOF WAR TIO ZOJ
 MUK POT DIN LAQ BAW VIS
 JUS NOG NUN GEZ TAR KEW
 JAZ PIB KEG RUD NEJ YUN
 JAG GIR LEP TOS JAN NER
 KUF BID MAC MID CIS JIN
 MOR TAV DEF PUS JIC XEN
 YAM MOF WUY VES XAQ RUM
 SOM FAG KAG TIR JIS DEY
 HUM KIT WAP TIS JOF ZAH
 MEG KID TOD NEM YUM GAJ
 KAZ BAT MUN CUP KIZ FOP
 SET QAK XOC KIN TIF XEV
 FET ZIL MOL SOC XOM DIN
 JAS ZEG JEM SAM SUM XAP
 PIT FOJ DUN VEX JER NEY
 LEZ RAX LUZ SAD NEX CAK
 ZUK YEG VET PER MEY DAR
 DIV NAX JAQ GAC NAQ DUB
 YIT TIG LIO CUF NOB NEM
 QET ZEK SUG VOT MOJ DIB
 ZID QAS W02 KOL DIO QUS
 BOL XAR KEM TEV DEX LEM
 DOL WIR SUK YEN JEW NOF
 MOP REZ DOG YOD XEM MOQ
 NOT MIZ TIV MUL XEC FEV
 SAX BIK NAT MUH YIM PIX NAR
 LAN YUX RAP SAZ LUY PIM YOW
 KAR ZAP CAB NAW MAN YOC QEG
 PEZ NOM KAL MEP BUT PAM CAG
 TIP XON ZET JEK ROJ SEV JUM
 WON DAK DEJ PAG JOQ WOM NIC
 FOX RIX BUL BOG PUQ M1W XIM
 MUX BAY NUG DAH WUP QEK QER
 QAM JED CAM FEZ CUB MEH VEK
 JIR GEF JEL PUT NUR VOZ PEB
 TOJ DIG MAG SEF RIN KAN FOV
 BOM ZAB GOM MAY ZAT YOM QUL
 LOM WES WIP ZIX XUR MUS NID
 WED SEO REG HUB VAK QIK RIY
 MEL TEL YAK VIF BIY WIR JIV
 GUY RUB LUM HIC KUZ PEF GEW
 JOD WAT YAN DIR COB FAW BOR
 DAP RAT REK XOB BEZ YUR QIV
 MAP FAK HAR ZIG VAR WEN KIG
 SUX NAL SOF SIY LOJ BOZ XUF
 KAY NUK WER REN ZIP CEL GOC
 DAY LEK COD TIY YUQ DEN LOV
 KEP RAW COP MOF RIJ YOT DUT
 ROQ LOK SEM SOP KAC LOP TOV
 LUC YUB SOT SOB WUM XAK WIO
 MAL LOT DEC FUR JUY SIZ ZAW
 WOS GEM JUG TAY TOQ YEZ COS
 NOC FUM BUP ZES GIZ FUK GOJ
 PAL ZIV NAD MAW YOK FOS MUB
 LUX RAY BEP TUN MEV SAH QAB
 JAF DOM PEG HAZ VAS TEP VUG
 BON CUX SAQ LIN ZUT SUV QOK
 NEP BUZ NUH REJ WEP QEV YIQ
 RET JAY VID YOS TUL YOV PUL
 YAZ PUG REY BIT XEM SAN CEY
 MIJ YIP WOB WEF QEP FUZ VOS
 MIP BIX ROV BUH TAJ MUJ KAH
 TOM TAG PUR KOD SUQ MIV DUK
 NOT HAO MAS VOD ZIK COT XAZ
 REC SOK HUD MAS VUP JUT KUM
 NOZ SEJ ROD WIZ LAD YOR WEC
 ROT YUP BOY CET TUB RIM CEF
 PAJ MET MIY MEN JUM MUV JEO
 MUT WOT YAX DOX GUF ZOY PUK
 DOP MUS QIY HEX XOP YUL VIR
 GAP RTP POX ZUX ZOQ GIP CIF
 BUF DUP JEH FEC KIY SUZ BEW
 DOH DIM BUC TAK SIM FIV ZOW

(Continued on next page.)

Figure 1 continued

[illegible]

Errors in Measurement

Two kinds of errors in measuring Ss' pronunciation latencies occurred in the present experiment. One kind of error resulted from erroneous responses due to extraneous noises that triggered the voice key. These were usually characterized by very short latencies (.18 sec or less). Another kind of error resulted from failure of the voice key to trigger because of a soft-spoken response by S. These errors were characterized by maximum latencies (3.0 sec).

These two kinds of errors could introduce bias that would affect spuriously the average pronunciation latency for a trigram. In order to reduce these effects, Chauvenet's criterion was used to reject extreme scores (Young, 1962). After deviant scores were rejected, the average latencies were recomputed. The P Lat scores presented for each trigram have been corrected using Chauvenet's criterion.

P Lat and Meaningfulness

The overall correlation between P Lat and Archer meaningfulness based on 2100 scores was $r = -.37$. Figure 2 shows the relationship between P Lat and Archer (1960) meaningfulness. The P Lat values shown are average P Lat values obtained by summing the P Lat values of individual trigrams contained in successive tenths of the Archer meaningfulness scale and dividing this sum by the appropriate N. The number of CVCs at each of the 10 data points are: 0-10, 121; 11-20, 187; 21-30, 204; 31-40, 233; 41-50, 164; 51-60, 142; 61-70, 181; 71-80, 165; 81-90, 223; 91-100, 480.

Figure 2 indicates a linear relationship between P Lat and meaningfulness. This finding is at variance with Underwood and Schulz's conclusions for rated pronounciability, which indicate that the "...rated ease of pronouncing the syllables increases from 0 percent M to approximately 50 percent M, with no appreciable change thereafter [p. 282]." Clearly, this is not the case in the present study.

Gorfein suggests that Underwood and Schulz's conclusions regarding the correlation between rated pronounciability and meaningfulness are spuriously high due to the fact that Ss' pronounciability ratings are contaminated by meaningfulness. The findings of the present experiment are consistent with this view. The P Lat measure obtained under a self-paced format appears to be relatively free of bias from other attributes of the stimuli, in particular meaningfulness. Thus, P Lat may be interpreted as reflecting a basic amount of time necessary to process information according to pronunciation rules primarily. As such, the data of the present experiment provide researchers with a unique set of stimulus materials.

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Fig. 2. The relationship between P Lat and Archer meaningfulness. P Lat values represent average values based on the number of trigrams at each level of meaningfulness.

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NOTES

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2. Now at Temple University. Reprint requests should be sent to Calvin F. Nodine, Department of Educational Psychology, Temple University, Philadelphia, Pa. 19122.
3. Errors in measuring P Lat due to erroneous responses accounted for 1260/21,000 responses for a 6% error rate. Because of these errors, 840
4. An alphabetical listing of pronunciation latencies for all 2100 CVC trigrams with standard deviations is available on request to the authors.