THE EFFECT OF LETTER STRING LENGTH ON THE SIZE OF THE VISUAL SPAN AND READING SPEED

by

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This paper is submitted in partial fulfillment of the
requirements for the degree of

Doctor of Optometry

Ferris State University
Michigan College of Optometry

May, 2012

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Has been approved

May, 2012

APPROVED:

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Ferris State University
Doctor of Optometry Senior Paper
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ABSTRACT

Background: The visual span has been defined as the number of letters that can be correctly discriminated at and around fixation without executing an eye movement. Legge, et al (2007), have implied that the visual span is one of the sensory bottlenecks that limit reading speed. This study investigated the effect of increasing string length on the size of the visual span and its effect on reading speed. *Methods*: The visual span was measured on 15 college-level subjects with both random trigrams and pentagrams. Reading speeds were measured using 3 letter words and 5 letter words that were randomly presently using the flashcard paradigm (FC) and the Rapid Serial Visual Presentation method (RSVP). *Results*: The reading span decreased by approximately 40% (Paired $t(14) = 30.44$, $p < 0.001$) when measured with pentagrams as opposed to the reading span measured with trigrams. A Two-Way ANOVA showed no significant effect of string length on reading speed ($F(1,59) = 2.72$, $p = 0.104$), no interaction effects between reading condition (RSVP or FC) and string length ($F(1,59) = 0.165$, $=0.686$), but a significant effect of reading condition (RSVP vs. FC; $F(1,59) = 30.36$, $p < 0.001$). *Conclusions*: Higher level reading processes can compensate effectively when low-level information in the visual span is significantly compromised or attenuated in normal readers.

ACKNOWLEDGMENTS

I wish to acknowledge the contributions and encouragement received from Dr. Avesh Raghunandan who graciously allowed me to collaborate with him on this research project.

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Andrea Sewell

Dr. Avesh Raghunandan

INTRODUCTION

Reading is an essential aspect of learning, and when the ability to read is compromised it can have a devastating effect to the individual. Great strides have been made in diagnosing learning disabilities such as dyslexia. There are many theories on the causes of dyslexia including the magnocellular theory, cerebellar deficits, phonological deficit, etc[11,12,13,14]. While it has been difficult to find repeatable evidence of a certain processes causing reading disabilities, many experts have found evidence linking dyslexia to a visual process[11,12,14].

Reading speed is cited often as one outcome measure of reading efficiency or ability. While this statistic is a single value characterizing the reading process, it represents the cumulative contributions from both low-level and high level perceptual processes. There are two different approaches that can be used to attempt to find an answer to the question of what limits reading speed. One approach that has been taken is to look at the top-down influence of the higher processing centers of the brain by trying to find the strategies of one reader compared to another as a reason for the difference between the individual reading speeds. Top down influences can include context, the reader's vocabulary level, word form recognition, past experiences, visual attention and education that have influenced the way the reader approaches a passage besides the fundamental skills of phonics and decoding. The alternative approach is to look for limits that the sensory system itself might place on a person's inherent reading speed. This could also be described as taking the bottom-up approach to find a reason for differences in reading speeds between individuals, and can include things such as visual acuity, eye movements, letter recognition, masking, processing speed, etc. One factor that has been isolated as a possible sensory bottleneck for reading speed is the visual span[1,2]. The visual span has been defined as the number of letters that can be recognized correctly within a line of text without moving the eyes. There have been a number of studies that have quantified the size of the visual span[2-4], and a subsequent study that shows support for the visual span as one of the limitations on reading speed[1].

A strong correlation has been found between the reading speed of an individual and the size of their visual span[2,3,9]. In these studies, the visual span was measured by flashing random 3 letter sequences (trigrams) at and around fixation, and recording how many letters the subject reported correctly in sequence. The results show that in general larger visual spans were associated with faster reading speeds. It was calculated that for every 1 character increase in the size of the visual span there was a correlated increase in reading speed of 35%[1,2].

Legge et al.[1,2] measured reading speeds with the flashcard paradigm and the Rapid Serial Visual Presentation (RSVP) paradigm. Legge, et al (2007), found a 1.4X increase in reading speeds measured using the RSVP method as compared to the flashcard method. He suggested that the RSVP method produced faster reading speeds because the subject was not slowed down by having to execute a saccade to read the stimulus.

Jacobs (1986) did similar research in this area and described the visual span as the functional field[5]. He found that the more complex the stimulus or the task the narrower the functional field became. He also found an increase in the size of the functional field when the subject was presented with words rather than letter strings suggesting word superiority (a higher order process). Carver (1990) showed that if the reading speed is calculated by how many letters are seen per unit time instead of words per unit time, then the reading speed will be about the same for easier and more challenging texts[6].

It can be inferred from the visual span hypothesis proposed by Legge et al. (1997, 2001, 2007) that a contraction in the visual span will produce a proportional decrease in the reading speed given the same experimental conditions[1,2]. In this study we show that increasing string length from 3 letters to 5 letters causes an approximate 40% contraction in the size of the visual span. However, despite the contraction of the visual span, reading speeds as measured with the Flash-Card and RSVP methods for random arrangements of 3 letter and 5 letter words, showed no significant differences.

METHODS

GENERAL METHODS

The visual span of 15 Optometry students were measured using random 3-letter trigrams and 5-letter pentagrams, using the method adopted by Legge et al[1,2]. In addition, reading speeds were estimated using two paradigms: a) The flashcard paradigm comprised 3 lines of three 3-letter or 5-letter high frequency words. B) The Rapid Serial Visual Presentation method (RSVP) employed 9 randomly selected 3 or 5 letter words from the same sample of words used for the flashcard paradigm (see Appendix B). Words were rapidly and sequentially flashed at a screen position centered about the fixation point. All stimuli were presented on a Dell Trinitron CRT monitor using a screen refresh rate of 120Hz. Letters were rendered in high contrast (0.8) black lowercase Courier font that subtended 0.4 degrees at the fixation distance of 0.57m. The screen background was bright white for all viewing conditions. Courier font is a "monospace" font because the letters have the same width for each character, i.e. they always take up the same amount of space. Inter-letter spacing was equivalent to 1.16X the height of a lowercase "x". In the case of the "Flashcard" paradigm, the inter-line vertical separation was equivalent to the height of a lowercase "x". All letters were constructed using Matlab™, and presented on a Dell Trinitron CRT monitor using the psychophysics Toolbox option[7,8]. The temporal presentation duration was calibrated with a photo-detector and an oscilloscope.

DETAILED METHODS

Subject selection

All subjects were graduate-level Optometry students between the ages of 23 and 28. The selection criteria included near VA's better or equal to 20/25 OD, OS, OU, an absence of any heterotropia and a heterophoria between 2 prism diopters of esophoria and 8 prism diopters of exophoria as determined with cover test at a distance of 50 cm. The subjects were required to have at least 40" of local stereopsis as measured using Wirt Rings along with at least 250" of global stereopsis measured using the Randot StereoTest. The NSUCO technique was performed to screen for overt pursuit, saccadic or fixation abnormalities[10]. A score of 4 and greater in ability, accuracy and head/ body movements was considered a passing score. The Visagraph™ was also employed as a screening test to ensure that the subjects' reading levels were above high school level (GLE = 10). The reading speeds and the grade level equivalency (GLE) were recorded for two trials using text passages corresponding to level 12. All subjects were given the same college level passages to read and had to respond to 10 true or false statements after reading through the passage once to ensure comprehension. The subjects were also asked about any existing reading, learning disorders, and/or developmental delays. Only those subjects who passed all 5 of the criteria and did not have a history of learning, reading and/ or developmental delays were included in the study (see Appendix A). All procedures were conducted with binocular viewing. All subjects provided written consent for voluntary participation in the study. Approval for the use of human subjects was granted by the Ferris State University Human Subject Review Committee.

Measuring the Visual Span with Trigrams and Pentagrams

The reading span in the present study was measured by adapting the "trigram" method proposed by Legge et al[1-4]. The reading span was measured for random 3-letter (trigrams) and 5-letter (pentagrams) strings presented on a computer screen at varying letter positions to the left and right of fixation. All letters were randomly selected from a sample of all 26 letters comprising the English Alphabet.

PROCEDURE: Prior to the presentation of each string sequence, subjects fixated a pair of 6 arc minute fixation squares vertically separated by a space of 72 arc minutes. In the case of the trigrams, the 3-letter string was randomly presented within 3 contiguous letter positions of 19 available positions tested (Figure 1). Each trigram was presented for 100 ms duration to prevent a saccadic movement that would allow foveal fixation of the trigram. Even though 19 letter positions were available (-9 to +9), only 15 letter positions (-7 through +7) were used in the analysis because it was only in these letter positions that the first, second or third letter of the trigram could be presented. Therefore each trigram was presented with either its first, second or third letter occupying each of 15 letter positions. Subjects entered their perceived sequence of letters using the keyboard, which then allotted a score of "1" for each letter entered correctly in its correct sequence and a score of "0" for every incorrect letter. The proportion of correct responses was tallied for each letter position. This value represented the cumulative proportion of correct responses for that letter position when it was occupied by the first, second and third letter of the trigram sequence. For any given letter position, a single block of trials comprised 10 repetitions when that letter position was occupied by the first through third letter of the trigram sequence. A completed session comprised 3 such blocks. Therefore, the proportion of correct responses for each letter position of the reading span was derived from a total of 90 (30x3) presentations.

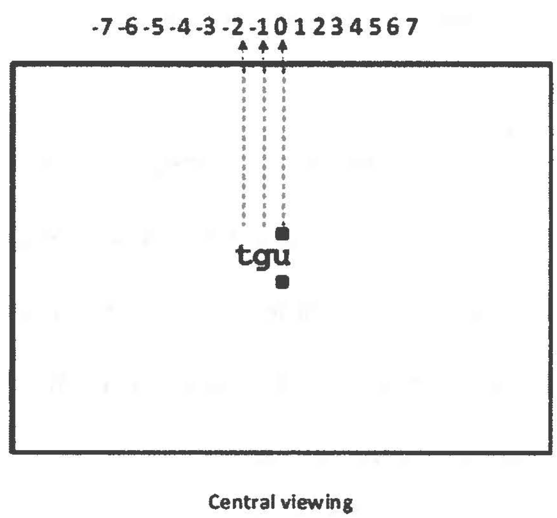

Figure 1: The above figure illustrates the condition in which a trigram "tgu" is presented in letter positions 0, -1, and -2 for central viewing. The numbers at the top of the figure depict the letter positions tested to the left (negative) and right (positive) of fixation (letter position 0).

In the case of the pentagrams, each string comprised 5 random letter sequences. In this case 23 letter positions (-11 to +11) were available, but only 15 letter positions (-7 to 7) were analyzed. The 23 letter positions were necessary so that each letter position spanning -7 to 7 could be occupied by the first, second, third, fourth and fifth letter of the pentagram sequence. For any given letter position, a single block of trials comprised 6 repetitions when that letter position was occupied by the first through fifth letter of the pentagram sequence. A completed session comprised 3 such blocks. Therefore, the proportion of correct responses for each letter position of the reading span was also derived from a total of 90 presentations.

Data Analysis of the Visual Span

To quantify the visual span obtained for the trigram and pentagram conditions, the proportion of correct responses for each letter position between -7 and +7 was converted into bits of information after correcting for guess rate[1]. The conversion of proportion correct to BITS was as follows:

$$BITS = [(Pcorrect - 0.038)/0.9615]*4.7$$

A proportion of 0.038 was equal to 0 bits (corresponding to the guess rate) while a proportion of 1, was equivalent to 4.7 bits. The visual span was then quantified by adding up the bits from all 15 letter positions (-7 to +7) (Figure 2). This was done for both the trigram and pentagram tasks.

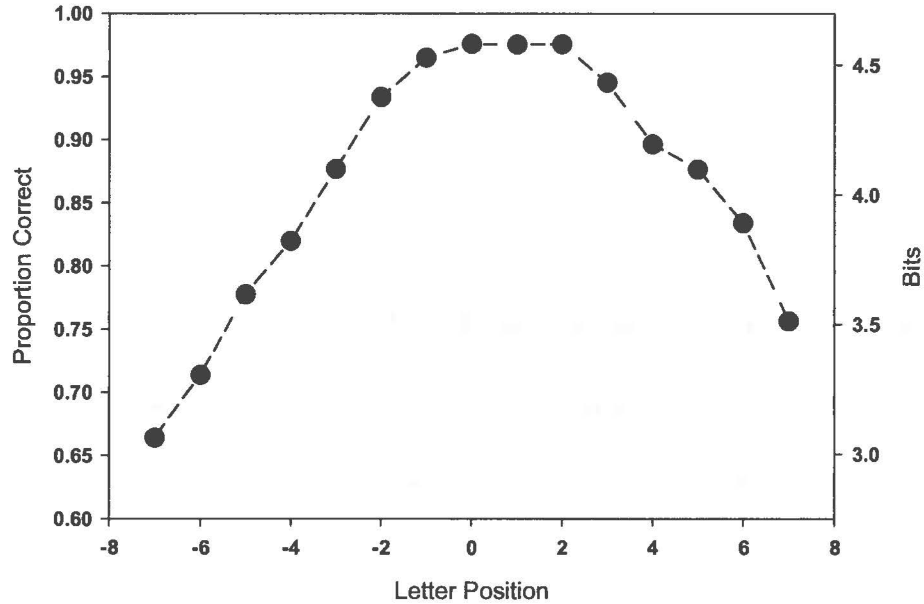

Figure 2: Sample Data for Visual Span Using Trigrams plotted as proportion correct (left ordinate) and equivalent Bits (right ordinate).

Measuring Reading Speed

To evaluate the effect of word length on reading speed, the Flashcard and the Rapid Serial Visual Presentation (RSVP) methods were employed using 3 letter words and 5 letter words. In the case of the Flashcard method a block of nine unrelated words arranged in a 3x3 fashion were presented for an amount of time varying from 0.1s to 3.0s (Figure 3). The words used were high frequency 3 and 5 letter words that were well below the average reading level of participants (Appendix B). The spacing between each 3-letter word within each line was increased so that the starting positions of the 3-letter words were the same as that of the 5-letter words. All words were left justified.

car	has	pie	coach	ahead	bongo
all	too	did	fruit	below	drift
tea	not	fog	blank	china	alone
Three-letter word Flash Card example			Five-letter word Flash Card example		

Figure 3: Flashcard examples for the 3 letter words (left) and 5 letter words (right).

For this test the subject was instructed to look at a central fixation target, and as soon as the block of words (Figure 3) appeared they were to start reading aloud the words from left to right from the top line down. The tester recorded the number of correctly reported words by using the keyboard. A correct score was given only if a word was correctly identified in its correct sequence. This test was done twice on each subject; once with 3 letter words and once with 5 letter words. The program reported the proportion of words that were identified correctly for each Flashcard time period. Each time period was sampled 5 times.

For the RSVP method each 3-letter or 5-letter word in a 9-word sequence was presented at the same location about the fixation point in rapid succession (Figure 4). This paradigm assessed reading speed of the words independent of the effects of saccadic eye movements. At the start and at the end of the RSVP test, the subject was presented with a series of lower-case “x” corresponding to the 3 and 5 letter positions of the words to be presented. This equalized the effects of masking of the first and last words presented in the sequence. The ISI is the inter-stimulus-interval which was approximately equal to the frame refresh rate (~8msec). Stimulus duration refers to the time period that each 3 or 5 letter word was presented. This sequence was repeated until

9 words were presented. In this method, the stimulus duration varied from 0.05 s to 0.35 seconds for each trial. As in the Flashcard method, the subject read the words out loud as quickly as they could, and the tester entered the number of consecutive correctly reported words and the program recorded the proportion of words correctly identified for each presentation time. Each stimulus duration was sampled 5 times. The sample of words used for the RSVP paradigm was randomly selected from the same sample of words used in the Flashcard paradigm.

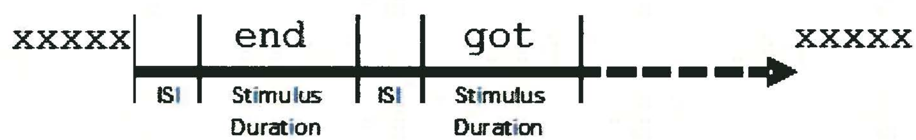

Figure 4: RSVP Trial Design: This figure demonstrates a time-slice through a typical RSVP trial for 3 letter words. A mask of crosses "xxxxx" were presented first, followed by 9 successive presentations of different 3-letter or 5-letter words for the specified stimulus duration. The trial ended with the presentation of the mask of crosses. The ISI refers to the time taken to refresh the frame which was approximately 8 milliseconds.

For each of these tests (visual span, Flashcard, and RSVP), a pretest using different letters and words than those used in the experimental trials was given to each subject to familiarize them with the conditions of the test.

Data Analysis of Reading Speed Trials

The proportion of correct words reported by the subject was plotted as a function of the stimulus duration. This produced a psychometric function. The resulting psychometric function was then fitted with a cumulative normal function by minimizing the sum of squares by varying the mean and standard deviation of the cumulative normal.

The stimulus duration that corresponded to 80% correct was calculated from the fitted curve. This value was then converted into words per minute (wpm) for each of the reading tests (RSVP (3 and 5-letter), Flashcard (3 and 5-letter)) for a total of 4 reading speeds calculated for each subject.

RSVP Reading speed (words per minute) = 60 / (critical speed 80%)

FC Reading speed (words per minute) = 60*9 / (critical speed 80%)

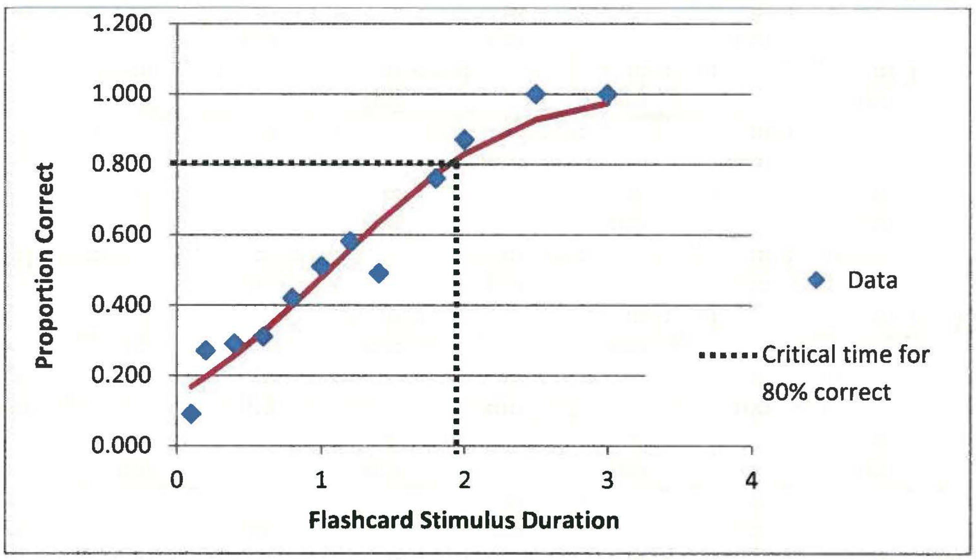

Figure 5: Sample Data for Flashcard Reading Speed with 3 Letter Words

RESULTS

The average visual span using trigrams was 60.17 bits (sd = 2.76), while the visual span using pentagrams was 36.89 (sd = 4.63). Therefore, the reading span decreased by approximately 40% when measured with pentagrams as opposed to the reading span measured with trigrams (Paired $t(14) = 30.44$, $p < 0.001$) (Figure 6). Furthermore, the right half of the visual span for both pentagrams and trigrams were wider than the left half of the visual span. For trigrams there was an increase in the visual span on the right side as compared to the left side of 2.48 bit ($\sigma = 1.32$), and for pentagrams the increase was 3.81 bits ($\sigma = 2.23$). This was true for all but one of the subjects. The average RSVP 80% critical reading speed was 247.42 (CI [221.54, 250.46]) words per minute (wpm) for the 3-letter words and 236.53 wpm (CI [203.41, 240.42]) for 5-letter words. The average reading speed for the flashcard paradigm was 299.20 wpm (CI [262.59, 303.50]) for 3- letter words and 281.20 wpm (CI [243.92, 285.58]) for the 5-letter words. A Two-Way ANOVA showed no interaction effects between reading condition (RSVP or FC) and string length ($F(1,59) = 0.165$, =0.686) (Figure 6), no significant effect of string length ($F(1,59) = 2.72$, $p = 0.104$), , but a significant effect of reading condition (RSVP vs. FC; $F(1,59) = 30.36$, $p < 0.001$) (Figure 7).

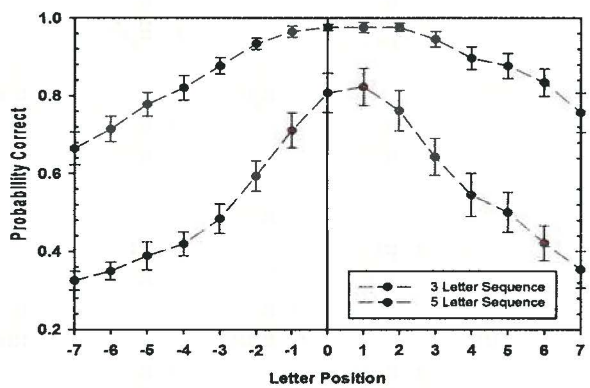

Figure 6: Probability of correct letter discrimination (+/- 95% CI) at each letter position measured using trigrams (Blue) and pentagrams (Red).

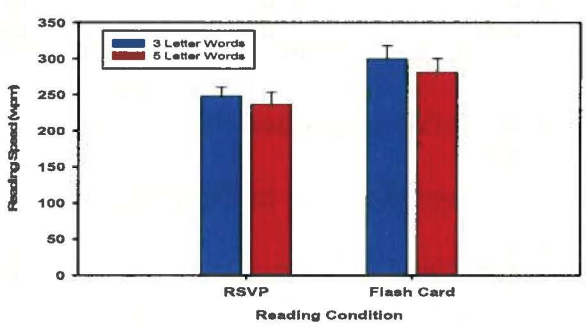

Figure 7: Reading speeds (+/- 95%CI) as measured by RSVP and FC using both 3-letter (Blue) and 5-letter (Red) words.

Figures 8 and 9 plot the visual span (in bits) and RSVP and Flashcard reading speeds, respectively. The linear fits represent linear regression fits to the data. Red filled symbols represent data for the 5-letter word conditions and blue represent data for the 3-letter word condition. It can be observed from both figures 8 and 9 that the data exhibits a bimodal distribution as a function of word length. This implies that visual span by itself is not a common scaling factor that limits reading speed. Stated differently, the result suggests that smaller visual spans are not associated with slower reading speeds.

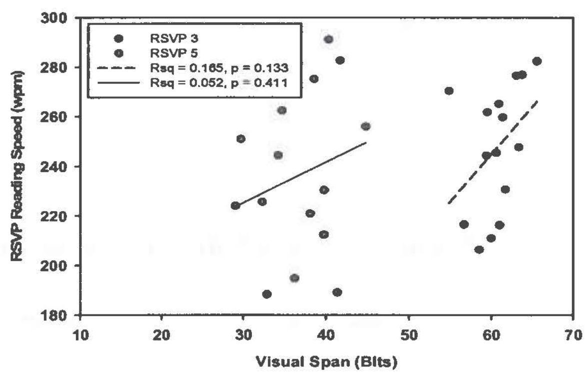

Figure 8: RSVP reading speeds for 3 letter (Blue) and 5 letter (Red) words plotted against visual span (in bits) for trigrams and pentagrams. Solid and dashed lines are linear regression fits to the data.

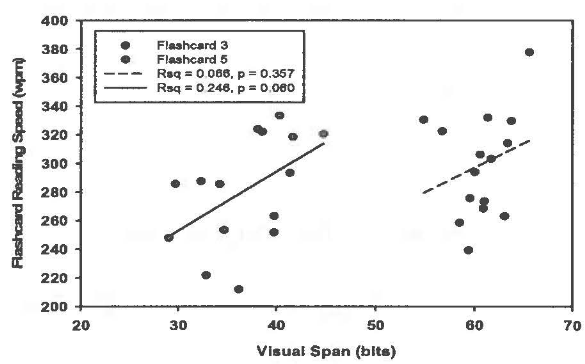

Figure 9: Flashcard reading speeds for 3 letter (Blue) and 5 letter (Red) words plotted against visual span (in bits) for trigrams and pentagrams respectively. Solid and dashed lines are linear regression fits to the data.

The reading speed as measured using Visagraph® was 260.7 wpm [222.24, 265.22]. Figure 10 compares the reading speeds measured by Visagraph®, Flashcard and RSVP methods. While Visagraph® employed silent, contextual reading as opposed to the flashcard and RSVP methods that were measured by having the subject read non-contextual words aloud, there still remains no significant difference between any of the measured reading speeds.

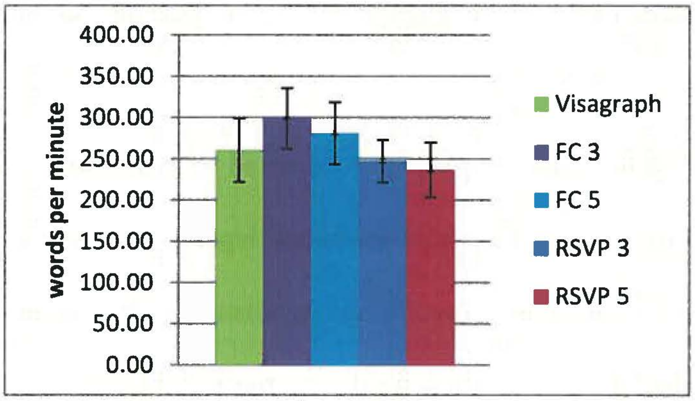

Figure 10: Comparison of reading speeds as measured by Visagraph®, and 3-letter and 5-letter word Flashcard (FC) and RSVP conditions with their respective standard deviations.

DISCUSSION

Our research conclusively shows that the visual span contracts with increasing string length, proving that the visual span is dynamic and not a fixed entity for normal readers. This agrees with Jacobs (1986) findings that the functional field while reading decreases with increasing difficulty of the text.

One factor that did play a part in measuring the size of the visual span using pentagrams was memory decay. To test the effect of memory decay, a pilot experiment was conducted where the pentagram was presented as before, but the subject was asked to report only the 1st, 2nd, 3rd, 4th or 5th letter of the string for a given trial. The 3rd, 4th and 5th positions of the pentagram all showed increases in the percentages correctly reported, but no significant changes to the 1st and 2nd positions. However, pentagrams presented in the central positions (-2 through +2) of the presentation field showed very little increase in the single position trials compared to the original trials that had the subject recall the entire pentagram. This result suggests that memory decay may be a factor affecting the size of the visual span, but its effect is more significant in the peripheral retina than in the central retina, and seems to be most significant for string lengths greater than 3 letters. While we have not quantified this effect completely, it nevertheless alludes to the possibility that temporal characteristics of peripheral letter processing may be inherently different from central processing.

There was no significant decrease in reading speed noted with increasing word length. This suggests that word recognition processes do not depend on accurate decoding of each letter comprising the word, specifically in normal adult readers. Instead of the brain processing 27 letters per presentation for the 3 letter word trials and 45 letters per presentation for the 5 letter word trials, it interpreted each trial as simply 9 words per presentation regardless of the word length.

One criticism that can be made of the methods used to assess reading speed is that random strings of words were used instead of presenting words in the context of a cohesive sentence. This effectively takes out the subject's higher order strategies of reading where it is not necessary to see the entire sentence to "read" a word. This can make the subject's reading speed vary from their functional reading speed for cohesive passages as measured by Visagraph™ where they are additionally being tested for reading comprehension. The RSVP and flashcard methods also required the subject to verbalize the words and not simply read them silently as they normal would. Despite all their differences, there was not a significant difference between the reading speeds measured by Visagraph™ compared to our measurements using the flashcard and RSVP method (Figure 10). Individual subjects varied between which method measured their reading speeds the fastest, but this again points to the fact that there are higher order processes and strategies that are employed in reading that affect the reading speed.

In our research we have found that there are no significant differences in reading speed of words having equivalent string lengths as random trigram and pentagram sequences, despite significant differences in their respective visual spans. This implies that in the case of normal readers, higher level reading processes can compensate effectively when low-level information in the visual span is significantly compromised or attenuated.

The conclusion of Legge et al. (2007) implied that the visual span was fixed for each person. We have shown that the visual span can be expanded or contracted given different string length. Therefore, higher level word recognition is relatively unaffected by significant attenuation of low level letter sequence information. These results suggest that the visual span may not pose as a sensory bottle-neck for word recognition, especially in normal adult readers. However this does not rule out the possibility of the visual span playing a role in limiting reading speed for younger children who have not yet developed higher order processes such as a well-develop lexical bank or for those individuals with reading disabilities. Further testing with these populations would need to be completed in order to determine if the visual span is a possible limitation of reading speed.

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APPENDIX A

SUBJECT ENTRANCE TESTING

SUBJECT ENTRANCE TESTING

Subject	Near VA's			Cover Test	Stereo	NSUCO	Visagraph ®	
	OD	OS	OU		Wirt Rings	Pursuits, Saccades & Fixations	Grade Level Efficiency	average reading speed (wpm)
1	20/15	20/15	20/15	1^XP	20" + global	Pass	13.4	286.5
2	20/20	20/25	20/20	2^EP	20" + global	Pass	13.8	309.5
3	20/20	20/15	20/15	2^XP	20" + global	Pass	13.2	280.5
4	20/15	20/15	20/15	4^XP	25" + global	Pass	13.1	231
5	20/20	20/15	20/15	1^EP	20" + global	Pass	10.1	194.5
6	20/20	20/20	20/15	3^XP	20" + global	Pass	13.3	261
7	20/15	20/15	20/15	ortho	20" + global	Pass	13.4	286
8	20/20	20/20	20/20	6^XP	40" + global	Pass	14	343
9	20/15	20/15	20/15	7^XP	20" + global	Pass	12.7	273.5
10	20/20	20/20	20/20	3^XP	30" + global	Pass	13.2	256.5
11	20/15	20/15	20/15	ortho	20" + global	Pass	12.9	245
12	20/15	20/15	20/15	4^XP	20" + global	Pass	13.7	260
13	20/15	20/15	20/15	2^EP	40" + global	Pass	10.7	226.5
14	20/15	20/15	20/15	2^EP	30" + global	Pass	11.2	250
15	20/20	20/20	20/15	4^XP	20" + global	Pass	10.9	207

APPENDIX B

3 LETTER WORDS AND 5 LETTER WORDS USED FOR TESTING READING SPEED

COMMON 3 LETTER WORDS

ace
add
age
ago
aim
air
all
and
ant
ape
arm
bad
bag
bar
bed
bee
beg
bet
bin
bit
bow
boy
bug
bus
but
cap
car
cat
cow
cup
cut
did
dim
dog
dot
ear
eat
egg
end
eye
fan
fat
fin
fly
for
fox
gas
gem
get
got
guy
had
has
hat
hen
his
hit
hog
hot
how
hug
ice
its
jam
jar
jaw
jet
job
jug
kid
kit
lap
law
lay
leg
let
lid
lip
lit
log
lot
low
mad
man
may
men
mix
mud
nap
net
nod
now
oar
old
one
owl
own
pad
pan
pat
pet
pig
pop
ran
rat
red
rip
rod
row
rub
rug
sad
sat
saw
say
sea
she
sit
ski
son
sun
tan
tar
tea
ten
the
tie
tip
toe
too
toy
van
was
who
why
won
yes
you
zoo

COMMON 5 LETTER WORDS

abide
above
acorn
actor
adapt
adore
adult
after
again
agent
agony
agree
alarm
album
alert
alien
allow
alone
along
amaze
angel
anger
annoy
apple
arena
arise
armor
arrow
attic
avoid
award
bacon
badge
bagel
banjo
basic
beach
beard
beast
begin
belly
below
bench
berry
bingo
birth
blame
blank
blimp
blink
block
blood
blush
bongo
brain
bread
break
broom
brown
brush
build
bunny
cabin
camel
candy
chain
chair
chalk
champ
chest
chick
child
china
cider
class
clean
climb
clock
clown
coach
cobra
comet
cover
couch
cough
count
crook
crumb
daisy
dance
delay
denim
devil
diary
dirty
disco
dizzy
dodge
dozen
drain
drama
drink
drift
droop
eagle
earth
elbow
empty
enemy
enjoy
favor
fairy
false
feast
field
fight
fizzy
flash
flood
focus
fresh
fruit
funny
ghost
giant
glass
goose
grass
grape
green
happy
heart
hello
horse
hotel
house
igloo
image
issue
jello
judge
juice
kitty
knife
label
laugh
laser
layer
learn
lemon
level
lodge
lucky
magic
maple
march
marry
match
maybe
mayor
medal
motor
mouse
never
night
noise
north
ocean
olive
onion
order
otter
panda
paper
paste
pearl
pedal
penny
phone
piano
piece
pinch
pizza
plane
plant
point
porch
print
prize
proud
punch
puppy
quack
queen
quick
quiet
radar
radio
ranch
raven
razor
ready
relax
reply
rhino
right
river
robot
round
royal
saint
salad
satin
sauce
scale
scarf
scary
score
sense
shape
shark
sharp
share
sheep
shell
skate
smart
smile
steak
sugar
sweet
table
taste
teach
tease
those
thing
throw
tiger
towel
trust
tulip
uncle
until
video
voice
waste
white
woman
zebra