Elderly adults are generally more susceptible to the detrimental effects of rapid speech rates when compared to young adults (Dagerman, McDonald & Harm, 2006; Fitzgibbons & Gordon-Salant, 1996; Letowski & Poch, 1996; Schmitt & McCroskey,1981; Titon, Koh, Kjelgaard, Bruce, Speer & Wingfield, 2006; Wingfield, 1996; Wingfield, Poon, Lombardi & Lowe, 1985; Wingfield, Waylan, & Stine, 1992; Zurif, Swinney, Prather, Wingfield, & Brownell, 1995). One factor impacting the rate of speech is the prosodic cue of pauses. Both the duration of the pause and the location of the pause within the phrase were found to impact semantic perception in young adults (Barrow, Givens, Stuart, Kalinowski, & Rastatter, 2005). Therefore, the purpose of this study was to examine the effect of age on the processing of pause duration cues in two different locations of a phrase.

Participants included 40 normal hearing adults [20 community dwelling elderly adults (10 male and 10 female) between the ages of 63 and 79 years (males M = 69.9, SD = 3.41; females M = 68.9, SD = 5.3) and 20 young adults (10 male and 10 female) between the ages of 20 and 40 years (males M = 27.9, SD = 4.1; females M = 26.2, SD = 3.7)]. All participants evidenced normal hearing sensitivity. No history of speech/language impairment, auditory processing difficulties, traumatic head injury, stroke, Attention Deficit/Hyperactivity Disorder or learning disabilities was evident as determined by answers on a prepared questionnaire for both groups. Visual screening was completed to ensure that all participants could clearly distinguish between the colors used in the study.

Individual utterances of the words “pink”, “green”, “white”, and “and” were provided by a male native-speaker of General American English. Utterances were recorded individually so that word duration and intonation variances would not be influenced by a natural tendency to add a contour that may bias the production. Computer editing was used to create the phrase “pink and green and white” so that it contained no interword pauses. The same target for the word “and” was used in both positions so that there would be no variation in production.

Two sets of 18 phrases were created from this original phrase. An initial silent interval of 25 ms was inserted immediately following the word “pink” for set one and immediately following the word “green” for set two. In each set an additional 25 ms was added to the each subsequent phrase so that the silent intervals ranged from 25 ms to 450 ms (each increasing by 25 ms increments). Through this method a complete set of 36 altered phrases was created.

Visual stimuli were computer-generated images depicting a black screen with three equally spaced rows of colored blocks (pink, green and white). The rows either displayed the pink block separated from the others, all blocks together or the white block separated from the others. A series of 6 such images was created depicting all of the possible arrangements for these three groupings of colored squares.

A laptop computer controlled random presentations of both auditory and visual stimuli and automatically recorded response accuracy. Participants were instructed to view the monitor, listen to the auditory stimulus through the insert earphones, and then depress the key corresponding to the row best displaying the meaning of the stimulus heard. A response was considered accurate if a participant chose the phrase grouping that corresponded to the location of the pause. Mean accuracy scores and standard deviations for each of the pause durations as a function of location the elderly and young adults are summarized in Tables 1 and 2 respectively.

A repeated measures ANOVA was performed on the data to determine the effects of age, pause location and pause duration on semantic perception. An arc sine transformation was completed prior to the analysis. The analysis revealed statistically significant main effects of location (F (1, 38) = 107.73, Greenhouse-Geisser p <.001) and pause duration (F (6.15, 208.34) = 175.77, Greenhouse-Geisser p <.001). Two statistically significant two-way interactions were found of duration by age (F (6.15, 237.15) = 3.19, Greenhouse-Geisser p = .005) and location by pause duration (F (7.027, 237.15) = 15.07, Greenhouse-Geisser p <.001). Additionally, a statistically significant three way interaction of location by pause duration by age was found (F (7.03, 237.15) = 3.767, Greenhouse-Geisser, p =.001).

In young adults the pause duration serving to cue semantic perception in the late location (following the word "green") was initiated at 100 ms, rose sharply, and reached a plateau at 175 ms. Elderly adults required a slightly longer pause duration (150 ms) before initiation occurred in this location. The rise-time was more continuous in nature rather than the sharp incline noted for young adults. Additionally, elderly adults did not reach a high level of accuracy (at least 90%) until the pause duration reached 300 ms. Therefore, pause duration values differed from the young adults for initiation of the shift by 50 ms and for consistent accuracy rate by 125 ms for this late location. So, while both young and elderly adults began to demonstrate a perceptual shift within a relatively similar window, elderly adults made a much more gradual, continuous shift in perception before reaching consistently accurate levels in the late location.

In the early location (following the word "pink"), a shift in semantic perception was initiated at 175 ms for young adults. The rise-time was slow and uneven with eventual plateau in accuracy at 350 ms. Conversely, in elderly adults the perceptual shift was initiated at 300 ms. Rise-time was slow and uneven, but never reached a plateau. It can be assumed that a plateau would be reached at some value greater than 450 ms in this location. Therefore, it can only be stated that the difference in the pause duration required to initiate the shift was 125 ms with the difference in a consistent accuracy rate in the early location remaining unknown. Therefore, young and elderly adults require much different pause duration levels to initiate a perceptual shift when the pause is located early in the phrase. However, the pattern of accuracy in this location was relatively similar. Figures 1 and 2 display response accuracy as a function of pause location and duration for each group.

While both elderly and young adults demonstrate significant differences in the use of pause duration cues dependent on the location in the phrase, the response profiles in the two age groups are quite different. Elderly adults generally require longer pause duration cues before they are able to initiate a perceptual shift. Once the shift is initiated, elderly adults require cues twice the length used by young adults to complete the shift when the pause occurs late in the phrase. In an early phrase location, elderly adults were not able to demonstrate accuracy rates of greater then 76% at 450 ms in duration. By understanding the magnitude of processing differences in normal populations, we may be better able to assist those individuals whose processing has been disrupted. Further examination in disordered populations is clearly warranted to better understand changes in processing abilities.

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Table 1. Percentage of Accuracy for Semantic Perception of Pause Duration as a Function of Location in Elderly Adults.

Location of Pause	1 (Pink)				2(Green)			
	Male		Female		Male		Female	
	M	SD	M	SD	M	SD	M	SD
Pause Duration (ms)								
25	1.7	5.4	5.0	11.2	23.4	36.9	15.2	14.6
50	3.4	7.2	5.1	8.2	36.6	39.1	24.9	32.6
75	1.7	5.4	8.4	11.8	21.7	34.3	30.0	32.0
100	11.7	17.6	8.3	14.1	31.7	35.4	31.7	33.6
125	8.3	26.2	8.3	14.1	45.0	36.8	56.6	22.6

150	26.8	31.2	16.8	23.6	59.9	33.4	73.5	21.1
175	23.5	33.5	25.0	28.7	60.0	31.5	81.6	16.5
200	25.1	32.6	18.4	24.2	68.3	35.4	80.0	17.1
225	48.5	30.9	33.5	24.9	71.5	22.3	86.6	13.1
250	46.8	33.2	33.3	32.2	81.6	21.5	89.9	16.1
275	58.3	36.2	30.0	30.0	86.5	20.6	90.0	13.9
300	72.2	29.5	49.9	36.0	89.9	21.2	91.6	11.8
325	56.5	28.5	53.3	29.0	89.9	21.2	91.6	11.8
350	74.9	35.4	53.4	30.2	89.9	16.1	93.3	16.1
375	66.7	31.4	56.6	29.6	91.6	16.2	89.9	11.7
400	73.4	29.5	60.0	29.6	88.2	15.8	98.3	5.4
425	75.0	29.6	70.1	28.1	89.9	11.7	95.0	11.2
450	80.0	31.2	71.6	23.4	98.3	5.4	94.9	8.2

Table 2. Percentage of Accuracy for Semantic Perception of Pause Duration as a Function of Location in Young Adults.

Location of Pause	1(Pink)				2(Green)			
	Male		Female		Male		Female	
	M	SD	M	SD	M	SD	M	SD
Pause Duration (ms)								
25	3.4	7.2	8.3	17.9	21.7	27.2	21.7	26.2
50	3.4	7.2	11.7	13.6	25.0	34.3	23.2	18.4
75	3.4	7.2	10.1	21.2	31.8	26.6	26.7	30.6
100	11.6	15.7	15.0	26.5	44.9	33.3	59.8	31.6
125	11.7	13.6	20.0	33.1	64.9	25.4	79.9	26.8
150	21.8	20.8	23.4	31.6	90.0	17.8	80.1	18.8
175	46.7	25.9	38.4	37.7	96.6	7.2	91.7	14.1
200	40.0	31.5	36.7	36.6	93.3	11.6	96.6	7.2
225	65.0	25.3	51.6	29.8	91.6	11.8	98.3	5.4
250	74.9	28.5	68.2	36.4	93.3	16.1	98.3	5.4
275	69.9	28.0	63.2	28.2	96.6	7.2	96.6	7.2
300	84.9	12.2	83.3	22.2	95.0	11.2	93.2	8.8
325	91.5	8.9	90.0	13.9	98.3	5.4	98.3	5.4
350	98.3	5.4	91.6	11.8	98.3	5.4	95.0	11.2
375	94.9	8.2	91.7	14.1	100	0.0	100	0.0
400	96.6	7.2	96.6	6.9	96.7	10.4	98.3	5.4
425	93.2	8.7	95.0	11.2	95.0	15.8	96.7	10.4
450	98.3	5.4	96.6	7.2	98.3	5.4	95.0	11.2

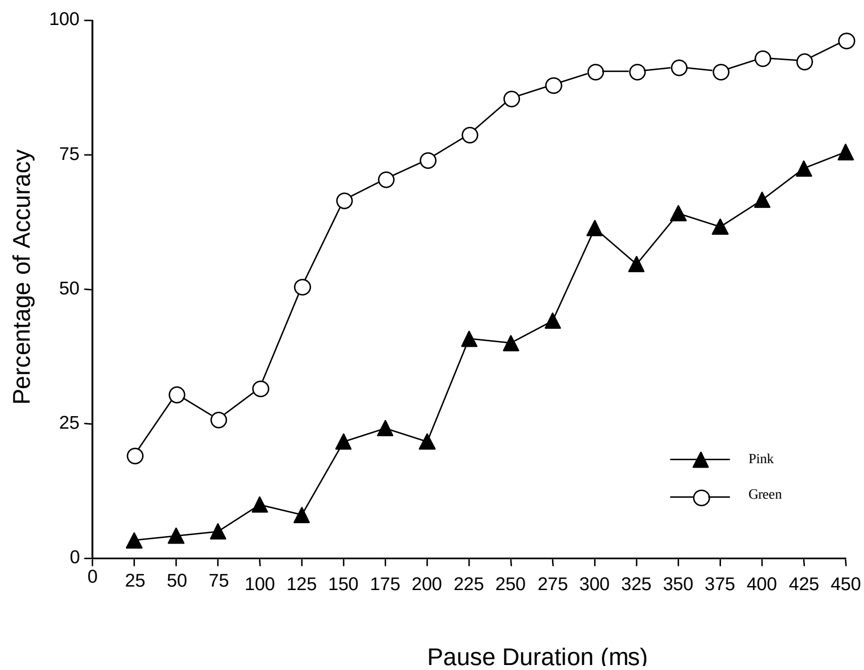

Figure 1. Percentage of response accuracy as a function of pause duration and location for the elderly adults.

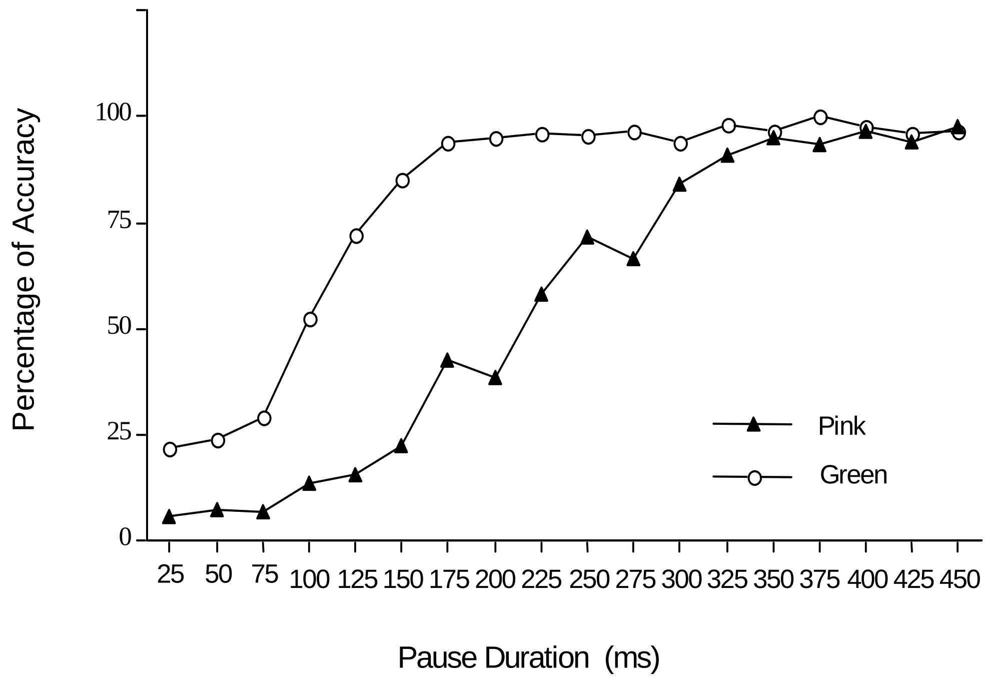

Figure 2. Percentage of response accuracy as a function of pause duration and location for the young adults.