Chapter 3

Study 2: Spatially Incongruent Audiovisual Stimuli

3.1 Overview

F Spatial co-location provides a strong influence on the perception of a unified multisensory event. Increasing the disparity between even very simple or non-related auditory and visual stimuli has been found to produce a wide variety of behavioral and perceptual effects, depending on the experimental paradigm. In previous studies, adults have been found to tolerate a surprisingly large degree of spatial disparity between auditory and visual stimuli while still maintaining a significantly faster response latency than toward a unimodal target (Frens et al., 1995; Harrington & Peck, 1998), but even small disparities have been found to have an effect on auditory spatial localization (Hairston et al., 2003). Infants between the ages of two and ten months of age were presented with spatially congruent and incongruent auditory and visual stimuli at $\pm 25°$ and $\pm 45°$ from midline, producing spatial disparities of $0°$ and $20°$ on the same visual hemifield, and $50°, 70°$, and $90°$ across opposing hemifields. In all but one case, spatially incongruent response latencies were slowed compared to the congruent condition, some significantly and some with mean latencies exceeding even the unimodal response time. We also found clear developmental differences in the response profile due to spatial disparity, depending on whether the visual component was at $25°$ or $45°$. Infants under four months of age showed only a moderate slowing effect at either visual eccentricity, while infants between six and ten months showed the beginnings of taking on an adult-style profile with latencies moderately slowed for small disparities, and extensively slowed for large—though not as finely tuned as adults. Infants between four and six months had a distinct disparity profile that suggests a possible switch from the more gross, mild interference of younger infants to the increasing interference profile of older infants and adults.

3.2 Experimental Design and Methods

3.2.1 Participants

Participation and recruitment was the same as in Study 1, with a few differences. Four age groups were defined, a priori: 2–4, 4–6, 6–8, and 8–10 months of age and during each visit, infants were tested with spatially congruent (Experiment 2) and spatially incongruent (Experiment 3) audiovisual stimuli. From the pool of valid candidates (experiments rated as Good or Okay), 15 infants were randomly selected for each age group within each experiment; not all infants completed both. Based on these criteria, a total of 38 individual infants (20 male, 17 female), ranging between the ages of 2.20 and 9.49 months, participated in this study, with some infants participating at more than one age group. Repeat participation was as follows: only one age group (16 infants), two age groups (9 infants), three age groups (7 infants), and all four age groups (6). Five adults (1 male, 4 females) also participated in this study (Table 3.1).

3.2.2 Apparatus and Stimuli

The experimental apparatus and stimuli used were the same as in Study 1. The spatially congruent experiment (Experiment 2) had both the auditory and visual components presented simultaneously at the same location (0°), for a total of four possible target stimulus positions. For the spatially incongruent experiment (Experiment 3), each component was presented simultaneously at one of four modules (±25° and ±45°), producing 12 target stimulus configurations, categorized by the

Table 3.1: Total number of subjects, their mean age and gender ratio, and total percentage of good trials (see *Methods*) for each age group and experiment. A subset of infants in each age group completed only one of the two experiments (last row).

Subject Info \ Age Group		2-4 mo	4-6 mo	6-8 mo	8-10 mo	adults
Experiment 2	N	15	15	15	15	5
	Mean Age	3.04 ± 0.6	5.07 ± 0.4	6.64 ± 0.6	8.86 ± 0.4	25 ± 7 yrs
	Male/Female	7/8	8/7	7/8	9/6	2/4
	% good trials	55.7%	63.0%	65.7%	62.0%	87.5%
Experiment 3	N	15	15	15	15	5
	Mean Age (months)	3.02 ± 0.5	5.17 ± 0.5	6.82 ± 0.7	8.83 ± 0.4	25 ± 7 yrs
	Male/Female	8/7	11/4	7/8	6/9	2/4
	% good trials	61.2%	62.1%	66.2%	63.9%	93.3%
# of subjects to complete both exps versus only one exp		10/5	11/4	11/4	9/6	5/5

eccentricity of the visual component (V_{ecc}: 25° or 45°) and the relative location of the visual and auditory components with respect to each other in the visual field: "Same" (auditory and visual stimuli on the same visual hemifield), "Opp/Sym" (located on opposing hemifields but at the same eccentricity), and "Opp/Asym" (located on opposing hemifields at asymmetrical eccentricities) (Figure 3.1). This configuration produced spatial disparity conditions of 20° ("Same"); 70° ("Opp/Asym"); and 50° or 90° ("Opp/Sym").

3.2.3 Procedure

Procedures for trial presentation were the same as in Study 1. Five blocks of trials were presented in Experiment 2 (spatially congruent), for a total of 20 trials, and six blocks of trials were presented in Experiment 3 (spatially incongruent)—with a short break after three blocks—for a total of 72 trials. The order of target presentation was randomized within each block.

Exclusion of trials was the same as before but with the definition of a wrong di-

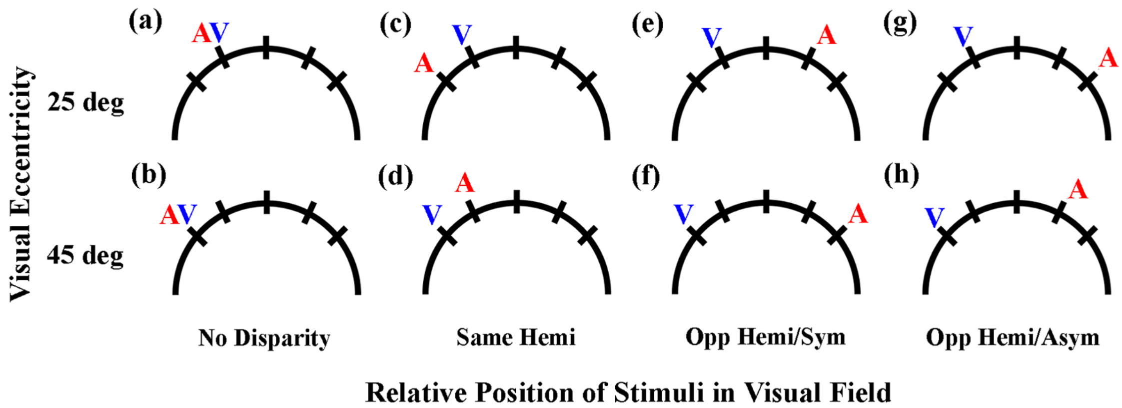

Figure 3.1: Target configuration characterized by a visual component at ±25° (top row) or ±45° (bottom row) with a spatially displaced auditory component. Spatially congruent configurations (Experiment 2) are shown at (a) ±25° and (b) ±45°. Spatially incongruent configurations (Experiment 3) have the auditory and visual components at one of three different relative positions in the visual field: (c) and (d) the same hemifield, (e) and (f) symmetrically, in opposing hemifields, or (g) and (h) asymmetrically, in opposing hemifields.

rection re-defined as a response in the opposite direction of both auditory and visual components ("Same"). Responses were characterized as being toward the visual component, the auditory component, or both. All good trials, for both Experiment 2 and Experiment 3, were pooled within each age group for purposes of statistical analysis (Table 3.2).

3.3 Results

We began our analysis of the infant response latency data with a 3-way univariate ANOVA (2 x 4 x 4), with visual eccentricity (25° and 45°) and relative position ("No Disparity", "Same", "Opp/Sym", and "Opp/Asym") as within-subject factors, and age group (2–4, 4–6, 6–8, and 8–10 months) as a between-subject factor, using a value of $p = 0.03$ for the significance threshold. We found a significant main effect for visual eccentricity, $F_{(1,3445)} = 122.4, p < 0.001$), for relative position $F_{(3,3445)} = 30.1, p < 0.001$), and for age, $F_{(3,3445)} = 368.3, p < 0.001$). There were

Table 3.2: The group mean was calculated for all relative position/eccentricity conditions.

	No Disparity				Same				Opp/Sym				Opp/Asym			
	25°		45°		25°		45°		25°		45°		25°		45°	
Age	**mean**	**se**	**mean**	**se**	**mean**	**se**	**mean**	**se**	**mean**	**se**	**mean**	**se**	**mean**	**se**	**mean**	**se**
2-4 mo	483	18	532	25	487	17	596	28	521	20	600	22	566	21	649	30
4-6 mo	356	11	387	11	320	7	404	12	377	13	392	13	395	14	392	12
6-8 mo	283	3	330	6	285	6	363	10	305	8	418	16	330	9	384	10
8-10 mo	286	5	296	5	288	6	356	9	327	14	409	13	357	13	395	13
Adults	172	12	177	11	210	10	215	11	221	10	245	10	226	10	252	10

also a significant eccentricity x position, $F_{(3,3445)} = 4.9, p = 0.002$), eccentricity x age, $F_{(3,3445)} = 4.4, p = 0.004$), and position x age, $F_{(9,3445)} = 2.4, p = 0.01$) two-way interactions. In adults, a 2-way univariate ANOVA (2 x 4) was also performed, with visual eccentricity and relative position as factors. There was a significant main effect for position, $F_{(3,409)} = 13.8, p < 0.001$) and a trend for significance for visual eccentricity, $F_{(1,409)} = 4.9, p = 0.041$).

3.3.1 Main Effect of Visual Eccentricity

Looking more closely at what might lie behind the main effects found, we first compared the response latencies for a visual stimulus at one of it's two possible eccentricities. When the visual stimulus was at 25° the response latency was much shorter (373 ± 4 ms) than when at 45° (431 ± 4 ms). Adults also showed a faster response latency when the visual stimulus was at 25° (207 ± 5 ms) than at 45° (222 ± 5 ms), though the difference was just shy of significance given our pre-defined significance threshold of $p = 0.03$. This was consistent with Study 1, where audiovisual targets produced shorter response latencies at 25° than 45° for across subjects.

3.3.2 Main Effect of Age

A repeated planned contrast analysis was then performed, comparing the response latency between each age group and the next oldest group. These comparisons indicated that there was a significant difference in latency between the three younger age groups ($p < 0.001$) but not between the two oldest groups (6–8 months versus 8–10 months, $p = 0.79$), with the largest jump in response latencies occurring between the two youngest age groups (Figure 3.2a), which is also consistent with the previous study. A second planned contrast was performed between the oldest infant group (8–10 months) and adults and found a significant difference ($p < 0.001$).

3.3.3 Main Effect of Relative Position in Visual Field

In order to examine the main effect for the relative position of the auditory and visual stimuli in the visual field, multiple *post-hoc* comparisons were performed using the Games-Howell procedure, due to our unequal sample size with non-homogenous variances (homogeneity of variances tested using Levenes Test of Equality of Variances, $p < 0.001$). Response latencies for trials where the auditory and visual components were in the same hemifield (”No Disparity” and ”Same” conditions) were significantly different ($p < 0.001$) from the two conditions where the targets were symmetrically or asymmetrically split across opposing hemifields (”Opp/Sym” or ”Opp/Asym”, without a significant difference between the ”No Disparity” and ”Same” conditions ($p = 0.33$) or between the two opposing conditions ($p = 0.43$) (Figure 3.2b). In adults, there was only a significant difference ($p < 0.001$) between the congruent ($0°$) and all non-congruent relative hemifield conditions (Figure 3.2c).

3.3.4 Eccentricity and Relative Position Interactions

Two-way univariate ANOVAs (2 x 4), with visual eccentricity and relative position as factors, were then performed for each of the four infant age groups. We found main effects for eccentricity ($p < 0.001$) for all four ages, and for relative position ($p < 0.001$) for 2–4 and 6–10 months olds with a trend for significance in 4–6 month

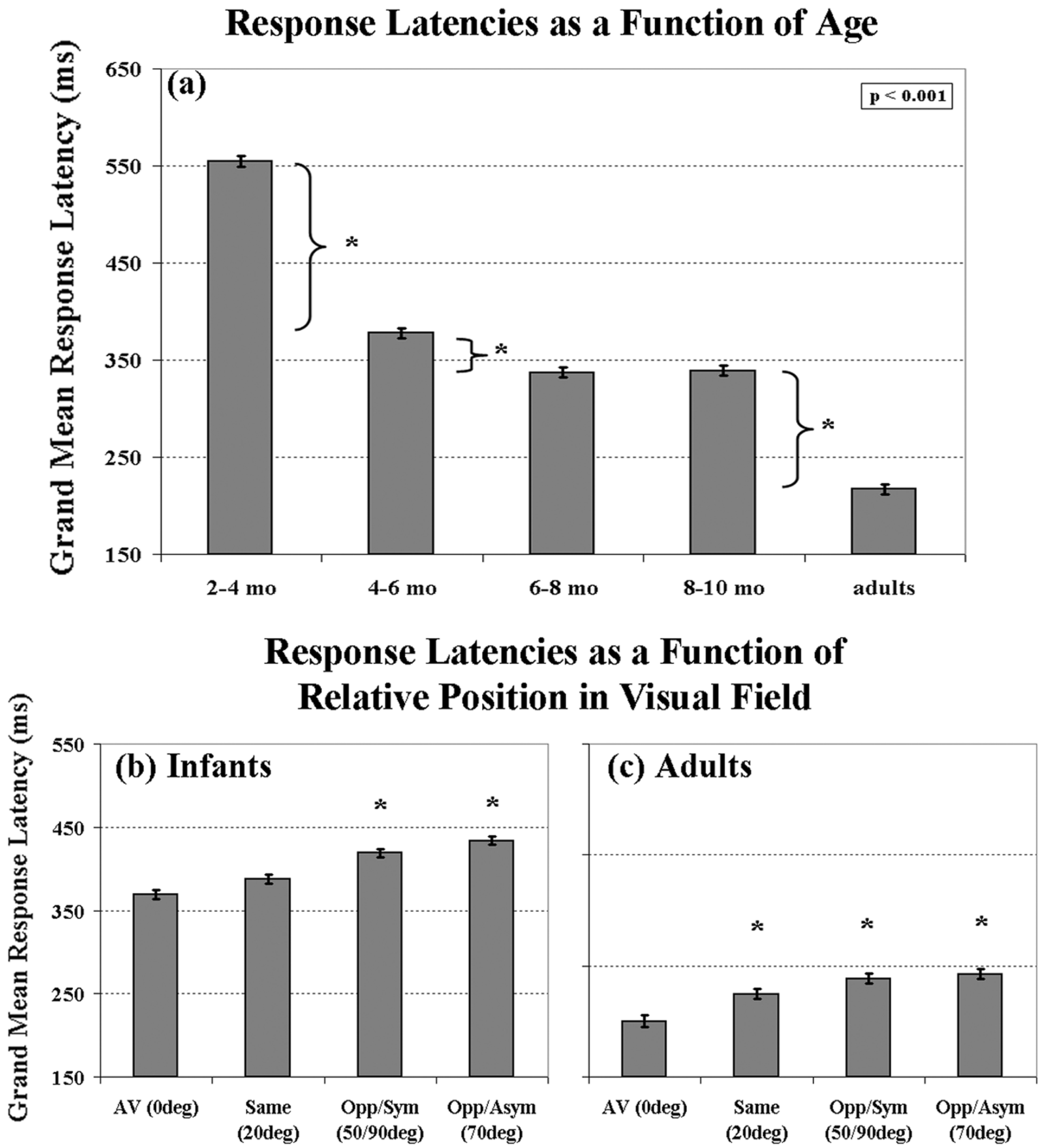

Figure 3.2: Response latencies as a function of (a) age and the relative position of the auditory and visual stimuli in the visual field for (b) infants and (c) adults. Error bars represent the standard error of the mean.

olds ($p = 0.04$). Two-way interactions between eccentricity and relative position ($p \leq 0.006$) were also found in each of the three oldest age groups (4–10 months).

3.3.5 Spatial Disparity

Considering that each of the relative position conditions roughly corresponded to different absolute spatial disparities (”Same” – 20°, ”Opp/Sym” – 50° and 90°, and ”Opp/Asym” – 90°), any effect of spatial incongruity between the auditory and visual components might have more to do with the absolute spatial disparity than with their relative positions in the visual field. We performed a series of 1-way ANOVAs(5) for disparity ($0°, 20°, 50°, 70°$, and $90°$), first pooled across all infant ages and visual eccentricities, and then within each age/eccentricity condition.

3.3.5.1 Pooled Results

From the pooled infant results, we found a significant main effect for disparity, $F_{(4,3472)} = 30.0, p < 0.001$), and a nicely increasing linear trend (least-squares fit, $R^2 = 0.9$) as a function of absolute disparity; response latencies increased approximately 10 ms for every 10° increased spatial disparity (Figure 3.3). Post-hoc multiple comparisons found that, while not significantly different from each other, the 0°, 20°, and 50° disparities did significantly differ from the 70° and 90° disparities ($p < 0.001$).

3.3.5.2 Eccentricity and Age

One-way ANOVAs for spatial disparity—over each age group/eccentricity condition—revealed a main effect for spatial disparity ($p \leq 0.015$) in three of the four infant age groups at both eccentricities (2–4 and 6–10 months. Linear fits showed the same increasing trend for increasing latency/disparity (Figure 3.4a, c, d) though 2–4 month olds at 45° showed a poor fit ($R^2 = 0.53$). *Post-hoc* multiple comparisons at this age and eccentricity showed a significant difference ($p = 0.016$) between 70° and all others. This general increase in response latencies with increasing spatial disparity is consistent with what was found in adults subjects (Figure 3.5), though with larger

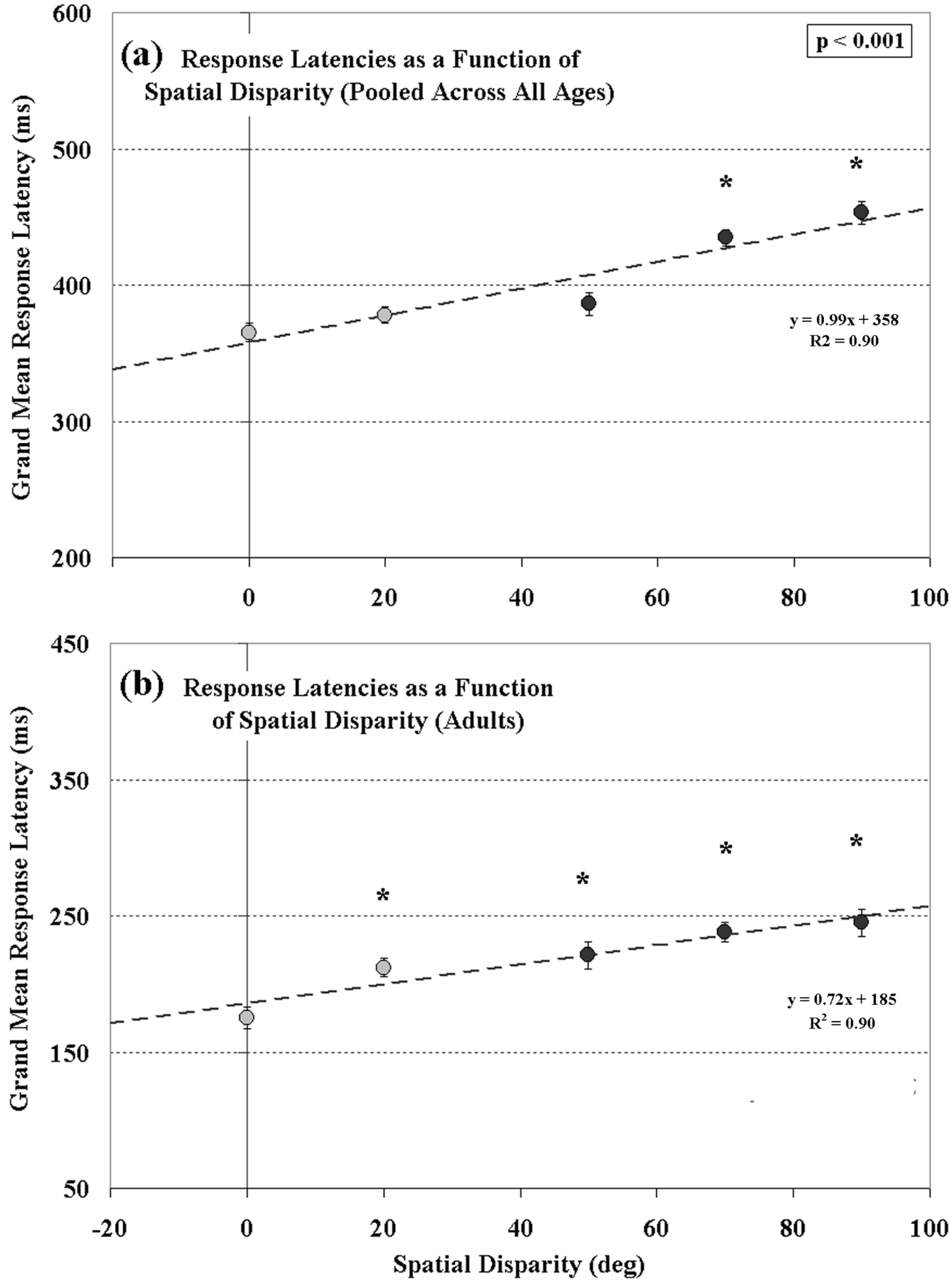

Figure 3.3: Response latencies as a function of spatial disparity, pooled across both eccentricities in (a) infants and (b) adults. Dark circles indicate auditory and visual components on opposing hemifields. Error bars represent the standard error of the mean.

difference between eccentricities in infants. With 4–6 month olds the analysis of variance found a main effect at 25°($p < 0.001$) but not 45°, and the significant condition showed a poor linear fit ($R^2 = 0.69$). Multiple comparisons found only the 20° disparity condition significantly differed from all others ($p = 0.029$), actually showing a shorter response latency than even the spatially congruent condition. The lack of a significant effect at 45° for 4–6 month olds is readily apparent by the completely flat profile for this eccentricity, indicating no change in mean response latency with spatial disparity (Figure 3.4b) Adults also showed main effects for spatial disparity at both 25°($p = 0.003$) and 45°($p < 0.001$); *post-hoc* multiple comparisons found all disparity conditions had significantly longer response latencies compared with the spatially congruent condition ($p < 0.02$).

3.3.6 Relative Position on Equivalent Disparities

Only two spatial disparity conditions (20° and 70°) were possible from two different positional configurations: (I) the visual component in a central location (±25°) and the auditory in a peripheral location (45°), or (II) the auditory component in a central location and the visual component in the periphery (Figure 3.6). There was a general trend for configurations where the visual component was in a central location and the auditory component in the periphery to have a faster response latency than the reverse configuration, even though the magnitude of the spatial disparities were the same. We performed 1-ANOVAs (2) for these configurations—(I) and (II)—at each age group for 20° and 70° disparity conditions. There was a significant effect ($RT_I < RT_{II}$) for all infant age groups for the 20° disparities ($p \leq 0.001$), but not for adults ($p = 0.5$). At 70° disparities, the response latencies with the visual component in the center (I) were only significantly faster ($p < 0.03$) for two infant age groups, 2–4 and 6–8 month olds, though it was borderline for significance ($p = 0.043$) for 8–10 month olds. There was no effect for positional configuration on equivalent disparities (20° and 70°) in adults ($p = 0.73$). In other words, having the visual component in the periphery produced a greater effect (slower response latency) than when centrally

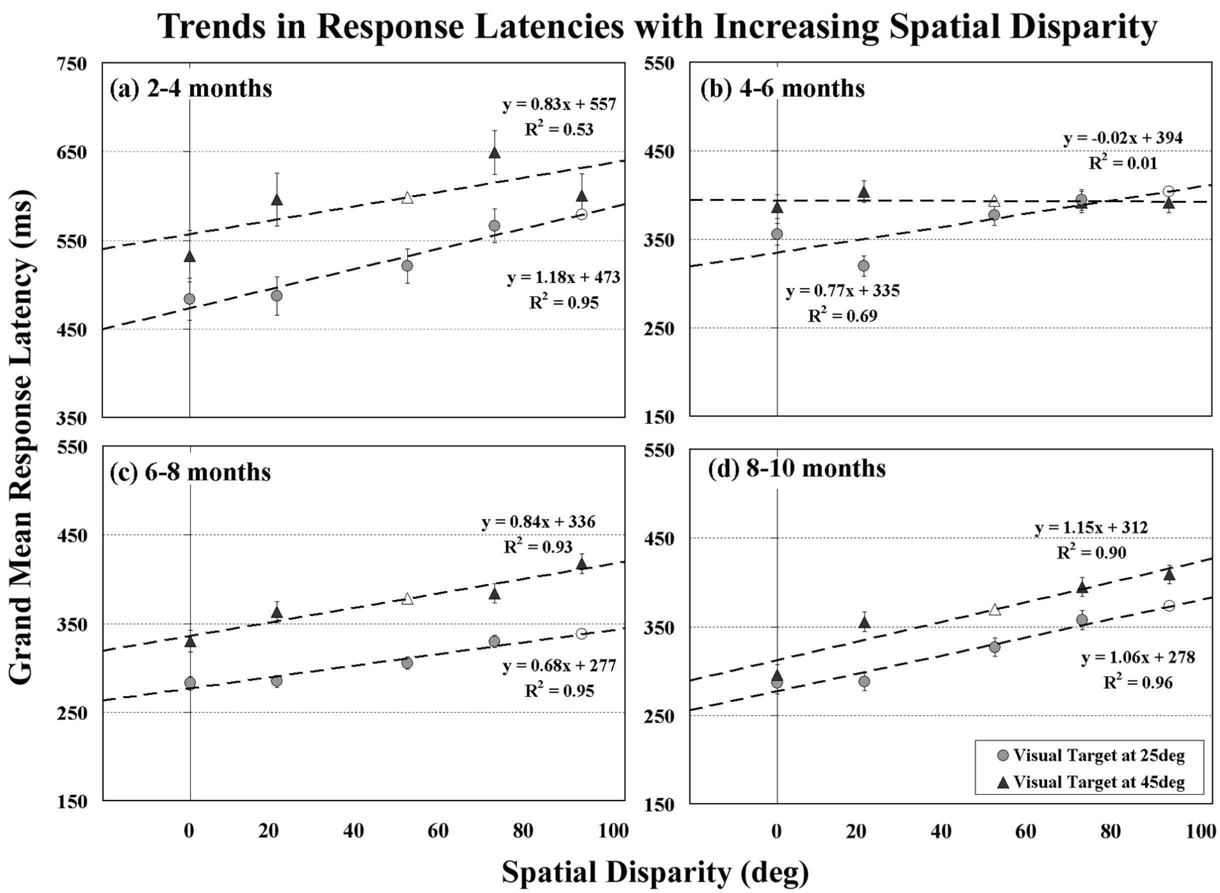

Figure 3.4: Response latencies as a function of spatial disparity for 25° and 45° visual eccentricities at (a) 2–4 months, (b) 4–6 months, (c) 6–8 months, and (d) 8–10 months. Error bars represent the standard error of the mean.

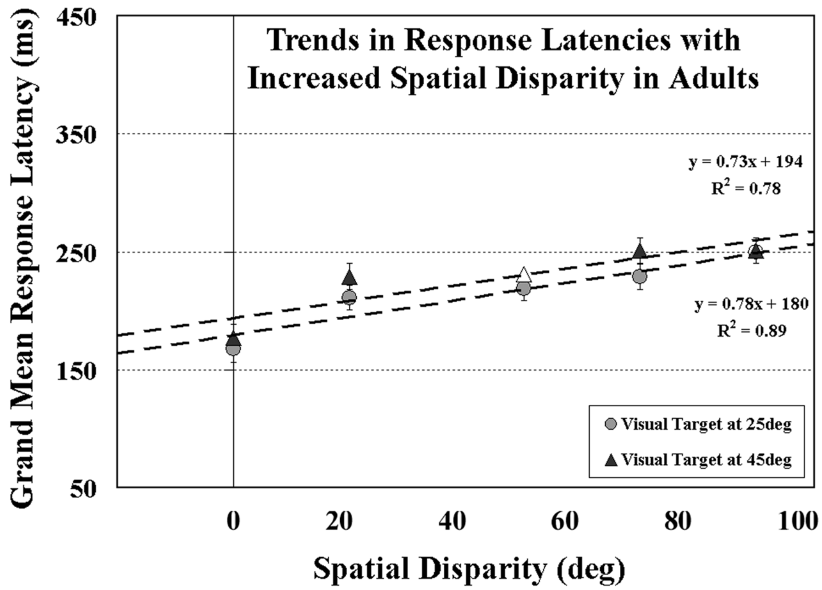

Figure 3.5: Response latencies as a function of spatial disparity for 25° and 45° visual eccentricities in adults. Error bars represent the standard error of the mean.

located, for all infants at small spatial disparities (20°), and for some infants (not 4–6 month olds, and only borderline for 8–10 month olds) at larger disparities (70°). This effect was not present in adults for either disparity.

3.3.7 Spatial Disparity: Facilitation versus Inhibition

It is not enough, however, to look just at the mean response latency for each spatial disparity condition; it must be put it into the context of how the response latencies change from the congruent condition as a result of the increasing spatial disparity. In our previous study, we found that the response latencies toward unimodal targets were faster in 8–10 month olds (at ±25°) by a magnitude sufficient to rule out statistical facilitation. Even younger infants showed a trend for a faster response latency for the bimodal condition, though it could be a response dominated by the faster modality system, likely vision. Given that latencies to audiovisual targets tend to be faster, the key question is: What does spatial disparity do to that faster response, and does it simply slow the facilitated response (latencies faster than unimodal) or

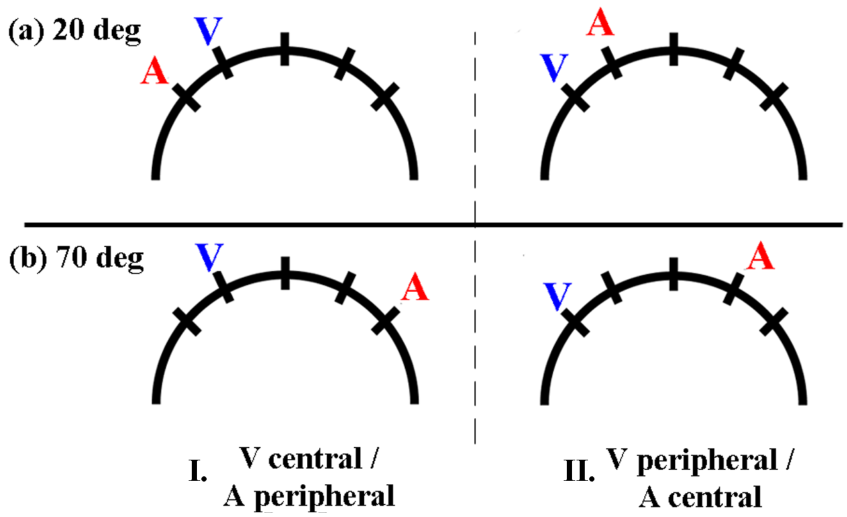

Figure 3.6: Two stimulus configurations are possible for both the (a) 20° and the (b) 70° spatial disparity conditions: (I) the visual component at ±25° and the auditory component at ±45°, or (II) the auditory ±25° and the visual component at ±45°.

perhaps tip over into an inhibited response (slower than unimodal)?

Unlike adults, who can be given instructions to perform a saccade toward either the visual or the auditory component when presented with both, infants were free to orient toward either as they chose, and up to this point, their responses when the auditory and visual components were split across opposing hemifields (disparities of 50°, 70°, and 90°) were pooled. A closer examination of the direction of their responses in these conditions found that the majority of responses for all ages was in the direction of the visual stimulus ($70 - -90\%$). This preference in response direction was different at one condition (auditory and visual targets symmetrically opposed at ±45°) for 4–6 month old, who showed an equal preference between the side with the visual stimulus (50.4%) as the auditory stimulus (49.6%) (Table 3.3); the mean response latency toward the auditory side (365 ± 19 ms) slightly shorter though not significant ($p = 0.048$) from the mean latency toward the visual (418 ± 18 ms).

Given the overall preference toward the visual component of the stimulus, and

Table 3.3: Percentage of responses toward the visual stimulus when auditory and visual stimuli are placed on opposing hemifields, either symmetrically or asymmetrically.

Age \ % response to V	Opposing/Symmetrically placed		Opposing/ Asymmetrically placed	
	25°	**45°**	**25°**	**45°**
2-4 month	82.3%	70.9%	77.8%	74.8%
4-6 months	85.3%	50.4%	80.2%	79.3%
6-8 months	92.8%	74.6%	88.6%	83.6%
8-10 months	89.5%	67.8%	88.9%	79.2%
Adults	93.9%	86.8%	95.7%	95.6%

how in the previous study, responses toward the visual-only targets were faster than toward the auditory-only targets, we then examined how the spatial displacement of the auditory component from the visual—at 25° or at 45°—effected the infants' response latencies. Calculating the difference between the spatially disparate and visual-only latencies, normalized by the spatially congruent latency ($\frac{(AV_d - V_0)}{AV_0}$), we then plotted the results for each age group and eccentricity (Figure 3.7). Spatial disparities to the left of the vertical axis are disparities on the same visual hemifield and those to the right are across opposing hemifields. Negative values indicate that the spatially incongruent latencies were faster than the visual-only latency (facilitatory) and positive values indicate slower (inhibitory). Given that we have only one disparity measurement for the "Same" hemifield (20°) and three for the "Opposing" hemifield (50°, 70°, and 90°), we chose to assume symmetry in our curve-fitting, although it is entirely possible that the same absolute disparity could produce different facilitory or inhibitory effects if presented within or across hemifields. The data were fitted by a 4th order polynomial. In all but one age group/eccentricity condition this produced a shallow u-shaped curve that varied at it's base (small disparities) and/or at the "height" of it's edges (larger disparities).

3.3.7.1 2–4 months

In the youngest infants, when the visual component was at 25° (Figure 3.7a), displacing the auditory component produced a broad, slow response that was facilitory in nature (faster than visual-only) for all disparities tested. When the visual component was at 45° (Figure 3.7b), there was a slightly more narrow base to the curve, though all disparities were, again, facilitory but slower than spatially congruent conditions. At both visual eccentricities, only 70° was significantly slower than 0°, and as was mentioned above, having the visual stimulus in the periphery was slower than if in the center region.

3.3.7.2 4–6 months

In 4–6 month olds, similar to younger babies, displacing the auditory stimulus from a visual stimulus at 25° (Figure 3.7c) and at 45°(Figure 3.7d) produced a slower—but still facilitory—response latency, but with several differences. At 25°, there was an increase in the difference between disparate and congruent latencies, shifting the whole disparity curve closer to the threshold set by V-only, and a flattening out of the curve at the larger disparities ($\geq 50°$). At 45°, there was an even more pronounced flattening of the disparity plot, suggesting that for a visual target in the periphery, the magnitude of the displacement had little to no effect in this age group, other than a general, mild interference. Of peculiar interest was the finding that only 20° was significantly different from 0°—it was faster—and no reasonable theory could be found at present.

3.3.7.3 6–8 months

In 6–8 month olds, the disparity profile at both eccentricities (Figure 3.7e, f) began taking on a more smooth, bowed u-shape, shifting upwards and providing the first indications that while small disparities $\leq 20°$) produce comparable response latencies to 0°, large enough disparities ($\geq 70°$) may be inhibiting the visual response. In particular, the extremely flat curve found in the previous age group (6–8 month olds) at 45° began to curve upward, with a narrowing of the base and with all three disparity conditions (20°, 70°, and 90°) now significantly slower than 0°.

3.3.7.4 8–10 months

In the oldest age group, the general profile transformation (at both eccentricities) that began in younger infants continued, in concert with a more distinct difference arising between the two curves. At 25°, there was a deepening of the u-shape, with the base becoming more flat while the edges steepened (Figure 3.7g). At 45°, the profile was reversed, narrowing at smaller disparities and flattening at the larger, suggesting that the displacement of an auditory target is able to have a greater impact on the response latency toward a peripherally located visual target (45°) than a centrally located one (25°).

3.3.7.5 Adults

For both disparity curves (Figure 3.7i, j), adults showed a very similar shape. A narrow region around the spatially congruent condition ($< 20°$) produced a facilitory response that quickly flattened to a more inhibitory response for all other disparities. In all cases, disparate response latencies were significantly longer than 0°.

3.4 Discussion

The purposes of this study was two-fold: to gain a better understanding of how (or if) spatial disparity influences the response behavior of infants under ten months of age, and the developmental profile that occurs over this age range and how it compares to adults. From the previous study, we found that response latencies toward synchronous, spatially congruent audiovisual targets were generally faster than response latencies toward auditory-only or visual-only targets, though only sufficiently faster to reliably violate the Race Model in the oldest age group (Neil et al., in press). So, how do the response latencies toward increasingly disparate audiovisual targets compare with spatially congruent conditions? In previous adults studies, a variety of

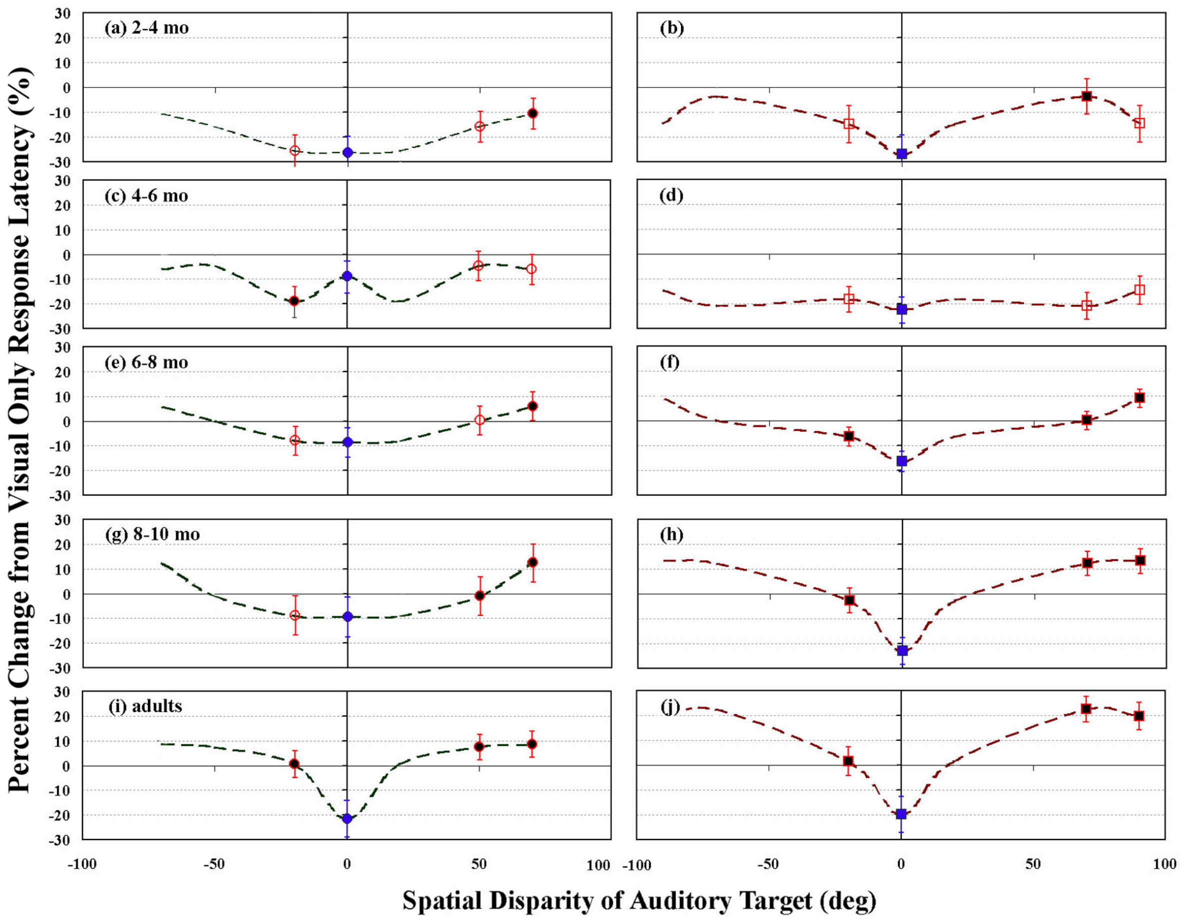

Figure 3.7: Percent change in spatially incongruent from visual only (Study 1) mean response latencies, normalized by the spatially congruent mean latency at the same eccentricity (25° and 45°) for (a) and (b) 2–4 months, (c) and (d) 4–6 months, (e) and (f) 6–8 months, (g) and (h) 8–10 months, and (i) and (j) adults. Filled data symbols indicate the response latency was significantly different ($p < 0.03$) than the spatially congruent audiovisual condition (blue symbol). Error bars represent the combined standard errors.

behavioral responses have been documented when presented with spatially disparate auditory and visual targets, including reduced saccade amplitudes and localization accuracy (Hairston et al., 2003; Lueck, Crawford, Savage, & Kennard, 1990), and increased response latencies (Frens et al., 1995; Harrington & Peck, 1998). This latter effect was verified by results for own adult subjects.

For most of the age groups (2–4, 6–8, and 8–10 months of age), infants shared a general trend of increasing response latency with increasing degrees of spatial disparity (approximately 7–12 ms per 10° disparity), with the fastest response latencies occuring at congruency. These results are consistent with an earlier study where spatially disparate visual stimuli (white dots) and auditory stimuli (500–14000 Hz tone) produced a similar decrease in audiovisual facilitation with increasing disparity, with the interference lasting for very large disparities, 45° or 55° across opposing hemifields (Colonius & Arndt, 2001).

In the youngest infants (< 6 months), an audiovisual target, whether spatially congruent or incongruent, seems to provide a general improvement in the response speed compared with a visual-only target, that is only minimally reduced for the largest disparity values. In 2–4 month olds, the disparity profile is consistent with a general improvement in response latency—compared to a unimodal stimulus—due to increased attentiveness for the more complex stimulus, with only gross effects of disparity on dampening the response speed, an effect that is only slightly more pronounced as the visual target moves toward the periphery. The differences between the two disparity profiles (Figure 3.7a, b) is consistent with the dominance of the visual system in the parafoveal region: A visual stimulus in this region is less influenced by a displaced auditory target than a visual stimulus in the periphery. In 4–6 month olds, response latencies were still faster than the visual-only condition (like younger babies), but the interference due to disparity become virtually insensitive to magnitude of disparity, with the exception of the faster response at 20° at 25°. This age group appears to be in an intermittent stage between the gross, mild interference of infants under four months, and the more facilitory/inhibitory profile found in older infants. As infants aged (6–10 months), the disparity profile shifted from one of slowed facilitation to one that began to straddle the boundary between a slowed but facilitatory response and an inhibitory one, and infants' response curves began taking on the more narrow profile of adults, but only at 45°.

A global view of these changes is this: In young infants (under six months), disparity produces a general, magnitude-insensitive dampening of the orienting response that results in response latencies slightly slower than a spatially congruent audiovisual response. In older infants ($>$ 6 months), the interference gets more finely tuned and magnified, and differences between disparity conditions become more apparent. Four to six months may represent a critical period in between these two states, possibly due to a switch from one less mature to another higher-level neural mechanism.

Although increasing the absolute spatial disparity between the auditory and visual stimuli in general slowed the response latency compared to the spatially congruent condition, the relative positions of the two stimuli (central versus peripheral) in the visual field also had some effect in infants. With an absolute spatial disparity of 20° or 70°, having the visual target in a central region (and auditory target in periphery) slowed the response latency less than an auditory stimulus in the central region for most infants. This result is consistent with what is known about the relatively stronger dominance of the visual system (in infants and in adults) in the paracentral region. Given the generally faster response latencies to visual-only targets than auditory-only targets at either $\pm 25°$ or $\pm 45°$ for identical stimulus intensities (Study 1, Figure 2.1b, Figure 2.2), and the higher percentage of responses toward the visual component when both auditory and visual stimuli were presented on conflicting hemifields (Table 3.3), it seems safe to conclude that infants at all age groups were more often orienting toward the visual component throughout. Given the greater visual acuity found in the paracentral region compared to the periphery, the visual system's stronger dominance in the former could be making it less susceptible to bias by a spatially disparate auditory stimulus, which is consistent with previous studies showing centrally located visual stimuli less effected by auditory-induced visual-illusions (Shams, Allman, & Shimojo, 2001; Thompson, Shams, Kamitani, & Shimojo, 2001). Similar asymmetrical effects of spatial disparity have also been seen in adult studies. Adult subjects who were asked to localize (pointing task) toward an auditory target, significantly mis-localized the target in the direction of a spatially displaced visual distractor (Hairston et al., 2003); the bias (magnitude of mis-localization) was larger when the visual distractor was more 10° more central than 10° peripheral to the auditory target.