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THE SPIRAL AFTEREFFECT. II. SOME INFLUENCES OF VISUAL ANGLE AND RETINAL SPEED ON THE DURATION AND INTENSITY OF ILLUSORY MOTION

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I. Introduction.

Visual illusions have been a persistent problem in aviation research. Many of these illusions are produced by misleading cues. Movement aftereffect, however, represents a different type of visual illusion—that which occurs following the cessation of real motion. Included among these is the spiral aftereffect—the apparent reversed motion of a spiral after it ceases spinning. The influence of visual angle upon the duration of movement aftereffects has been typically approached in past studies by varying stimulus size at a constant distance. Infrequently, distance variation with the same size stimulus has been employed,[9 10 13] and in one investigation,[1] both size and distance were alternately varied to produce the same visual angles. Most of the studies used no more than two or three visual angles and the conclusions reached by the various investigators are in conflict.

Thus, Freud[4] found a positive linear relationship for spiral aftereffect (SAE) duration scores using visual angles of 2°, 4°, and 8°, but McKenzie and Hartman[14] obtained no significant differences among scores with angle variations of 2° 8′, 4° 14′, and 6° 22′. Holland[12 13] duplicated the latter result with angles of 4° and 6°. However, Pickersgill and Jeeves,[15] using visual angles within the same range, found a nonlinear effect: a significant increase from 2° 52′ to 5° 44′, but a decrease at 11° 26′. Similarly, Fozard, Fuchs, Palmer, and Smith[3] found, with three visual angles, that duration scores were highest at either 2° 23′ or 4° 46′, but decreased notably at 9° 23′.

Granit[9 10] used a wide range of visual angles, varying the distance of his stimulus—a waterfall drum—from the observer. He found a marked peak in duration scores between 2° to 4° of visual angle. He noted that as visual angle decreased, so must the retinal speed—the speed of the stimulus pattern at the eye, as distinct from the physical speed of the stimulus. As the drum's distance from the retina increased, the retinal image it formed would diminish, and since the drum maintained a constant speed, a given point of the stimulus pattern would move through a smaller distance per unit time across the retina. The retinal speed, "which actually establishes the speed sensation," would be less.

Scott and Noland,[17] re-emphasizing the importance of retinal speed, presented a formula for calculating the "speed of eliciting motion" (SEM), which subsumes visual angle as a factor and is expressed in minutes of arc per second (minarcs/sec.). They calculated the SEM for three previous studies, those of Scott,[16] of Granit,[9 10] and of Freud,[4] and found that the aftereffect in each study increased from 30 to 132 minarcs/sec. and then declined. They concluded that aftereffect duration could be predicted on the basis of SEM alone, though other variables might also influence it.

Collins and Schroeder[1] varied visual angle by both size and distance manipulation, using nine visual angles ranging from 1° 12′ to 18° 56′. They confirmed the peak in duration scores from 2° to 4° reported by Granit. They also calculated SEM for their data and for the data of Fozard *et al.*[3] They found that for their own data, SAE durations increased from 30–60 minarcs/sec., declining thereafter. But for the data of Fozard *et al.*[3], peaking occurred at considerably higher

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SEM values depending upon the comanipulation of other variables, although visual angle appeared to be a dominant factor.

Though computed after the fact from studies designed to test the influence of other variables, SEM has never been systematically manipulated in reported experiments. The present study was designed to evaluate its influence and, using variations of both size and distance across a wide range of visual angles, to obtain information concerning the influence of visual angle upon the duration and perceived intensity of the spiral aftereffect.

II. Method.

Subjects. Subjects were 10 paid male volunteers, 20–29 years of age, who met the visual requirements for "mechanics and skilled tradesmen" on the Bausch and Lomb Ortho-rater: uncorrected distant acuity of at least 20/30, near acuity at least 20/25, normal muscle balance, and normal depth perception. Actual perception of the illusion was required in preliminary trials which also served as demonstration and practice.

Apparatus. The subject observed the spirals in a 48–foot visual alley, at one end of which was the enclosed, illuminated observer's box. The subject sat with his head positioned in a chin rest and sighted the spiral through a binocular eyepiece. The sides and far end of the alley were draped in white; the floor was tiled in a light-dark gray checkerboard pattern. Fluorescent lighting recessed in the ceiling was uniform along the length of the alley.

Six spirals of 4–, 8–, 10–, 12–, 14-, and 16-inch diameters were used. Each was a photographic reproduction of a three-throw arithmetic spiral with the white background area equal to that of the black spiral coil. These were rotated so as to produce an expanding aftereffect.

Attached to the drive shaft of the variable-speed motor was a Plexiglas disc with 12 magnets mounted at its circumference which, as the motor revolved, induced current in a solenoid. This, in series with a diode rectifier, sent a direct current to a voltmeter. A calibration curve, derived by use of an electronic digital counter, related the readings of the voltmeter to motor speed so that a given motor speed could be obtained by adjusting the resistor speed control until the voltage corresponding to that speed registered on the voltmeter.

The motor-voltmeter apparatus was set on a wheeled cart, on one side of which was mounted a flat-gray plyboard screen (17 × 18 inches) which faced the observer and served as a viewing background. Spirals were attached to the drive shaft of the motor which projected through a hole in the screen.

Conditions. There were five conditions: (1) With *angle constant* (A), the six spirals were used at distances varied to produce a constant visual angle (4°), and both retinal speed (50 minarcs/sec.) and motor speed (75 r.p.m.) were constant; (2) with *size constant*, an 8–inch spiral was employed at distances ranging from 2.37 ft. to 38.18 ft., giving visual angle variations from 1° to 16°; (3) with *retinal speed* varied from 20 to 200 minarcs/sec. (S_1), or held constant, at 20 or at 50 minarcs/sec. (S_2). (Limitation of motor speed capacity precluded the use of one constant retinal speed from 1° to 16°. The lower value was used at 1° and 2°; both values were used at 4° as a check upon continuity of function.); (4) with *distance constant*, the six spirals were viewed at a distance of 4.77 ft. giving a visual angle from 4° to 16°; (5) with *retinal speed either varied* from 50 to 200 minarcs/sec. (D_1) or *held constant* at 50 minarcs/sec. (D_2). These conditions were presented to the subjects in counterbalanced order, one condition per day for 5 consecutive days. The various size-distance-speed combinations within each condition (see Table 1) were almost completely counterbalanced among subjects.

Pre- and Post-Trials. To test for possible fatigue or habituation effects either within a day's session or over the 5 days, a standard stimulus (an 8–inch spiral at 9.55 ft. rotating at 75 r.p.m.) was presented in two pre-trials and two post-trials for each session. Both duration and intensity measures were obtained. The intensity of the aftereffect in the first pre-trial was arbitrarily called "100%" and served as the standard against which all intensity judgments were made during that session.

Procedure. Each trial was immediately preceded by a 15–second period with the subject's head positioned at the eyepiece, but with his eyes closed. This procedure was necessary in order for the motor to reach and stabilize at the desired speed at very low r.p.m. At a signal from

TABLE 1.—The Stimulus Conditions Used in the Various Sessions

Size Constant Sessions:

Spiral size (Inches)	Distance (Feet)	Visual angle (Degrees)	SEM* at motor speed of 120 r.p.m. (minarcs/sec.)	Motor speed for 20 minarcs/sec. (r.p.m.)
8	38.18	1	20	120
8	19.29	2	40	60
8	9.55	4	80	30
			SEM at motor speed of 75 r.p.m. (minarcs/sec.)	Motor speed for 50 minarcs/sec. (r.p.m.)
8	9.55	4	50	75
8	4.77	8	100	37.5
8	2.37	16	200	18.8

Distance Constant Sessions:

Spiral size (Inches)	Distance (Feet)	Visual angle (Degrees)	Motor speed for 50 minarcs/sec. (r.p.m.)	SEM at motor speed of 75 r.p.m. (minarcs/sec.)
4	4.77	4	75	50
8	4.77	8	37.5	100
10	4.77	10	31.3	125
12	4.77	12	25	150
14	4.77	14	21.5	175
16	4.77	16	18.8	200

Angle Constant Session:

Spiral size (Inches)	Distance (Feet)	Visual angle (Degrees)	Motor speed (r.p.m.)	SEM (minarcs/sec.)
4	4.77	4	75	50
8	9.55	4	75	50
10	11.93	4	75	50
12	14.32	4	75	50
14	16.70	4	75	50
16	19.09	4	75	50

SEM refers to the speed of eliciting motion of the stimulus.

TABLE 2.—Means and standard deviations for the duration (in seconds) of the spiral aftereffect. Each mean is based on an average of three judgments for each of 10 subjects.

Condition		Distance constant (4.77 ft.)					
		4°	8°	10°	12°	14°	16°
D^1	M	14.62	14.26	14.73	13.05	12.77	13.58
	SD	10.61	10.63	12.02	10.96	11.32	11.90
D^2	M	14.43	13.30	14.36	13.67	12.39	14.15
	SD	6.72	6.07	6.96	7.04	6.34	8.48

Condition		Size constant (8 inch spiral)					
		(Spiral speed: 120 r.p.m.)			(Spiral speed: 75 r.p.m.)		
		1°	2°	4°	4°	8°	16°
S^1	M	16.51	16.91	16.11	15.65	13.88	9.80
	SD	6.51	7.39	7.23	7.08	9.09	8.62
		(20 minarcs/sec.)			(50 minarcs/sec.)		
S^2	M	19.47	14.80	13.33	17.42	12.44	9.52
	SD	9.95	8.66	7.85	11.65	8.71	9.86

Condition		Angle constant (4°)					
		4 in.	8 in.	10 in.	12 in.	14 in.	16 in.
A	M	16.42	16.41	17.71	18.02	19.25	19.34
	SD	10.97	9.35	9.45	9.68	9.81	11.93

the experimenter, the subject viewed the rotating spiral for 15 seconds and then maintained fixation while marking the duration of the illusion by pressure on a microswitch which was connected to a time clock. When the duration score was recorded from the clock, the subject rated the intensity of the illusion on the basis of the day's 100% standard.

TABLE 3.—Means and standard deviations for the rated intensity (in percent) of the spiral aftereffect. Each mean is based on three ratings for each of 10 subjects unless otherwise indicated.

Condition		Distance constant (4.77 ft.)					
		4°	8°	10°	12°	14°	16°
D^1	M	61.00	63.20	59.50	51.4	48.30	52.60
	SD	27.54	27.45	32.93	30.90	32.13	31.39
D^2	M	67.70	64.50	53.10	49.20	51.80	60.80
	SD	22.20	22.70	30.26	33.77	29.01	31.59
Condition		Size constant (8-inch spiral)					
		(Spiral speed: 120 r.p.m.)			(Spiral speed: 75 r.p.m.)		
		1°	2°	4°	4°	8°	16°
S^1	M	132.70*	103.70*	81.30	77.20	59.80	26.90
	SD	130.65*	43.18*	19.93	29.17	20.88	23.75
		(20 minacrcs/sec.)			(50 minarcs/sec.)		
S^2	M	109.40	79.20	53.70	76.00	50.50	29.30
	SD	54.20	34.21	28.59	16.69	27.76	26.54
Condition		Angle Constant (4°)					
		4 in.	8 in.	10 in.	12 in.	14 in.	16 in.
A	M	69.20	73.60	71.10	73.50	78.00	85.30
	SD	25.13	16.33	17.17	21.83	17.45	16.98

*For N=9 (see text and Figure 2), these values are:

	1°	2°
M	91.89	91.11
SD	21.60	17.73

III. Results.

Average of the three duration scores and of the three intensity ratings for each subject at each trial setting were obtained. These means were then averaged to provide a group mean for each setting. These, presented in Tables 2 and 3 and plotted in Figures 1 and 2, show, for both duration and intensity measures, different functions with size variation and distance variation, and a sharp divergence from the expected horizontal, straight-line function with visual angle and retinal speed held constant.

Visual Angle

Visual Angle Constant.

A: With a systematic increase of size and distance to maintain a 4° visual angle, and with r.p.m. and SEM constant, the aftereffect might be expected to be essentially the same in duration and intensity at each setting of the A session. Instead, duration scores (Figure 1a) increased significantly ($t=3.257$; $p<.01$) from the smallest (closest) to the largest (farthest) spiral. Intensity ratings (Figure 2a) showed a similar increase, but the rise just failed to reach significance at the .05 level ($t=2.194$; t of 2.262 required for significance at .05 level). Therefore, though visual angle was constant, the aftereffect increased in duration (and in intensity) as size and distance increased.

Distance Constant.

D_1 and D_2: When visual angle was varied by manipulating spiral size at a constant distance, no significant effect upon duration scores (Figure 1b) or intensity ratings (Figure 2b) was found in either the D_1 or D_2 sessions. There may be a slight tendency for duration and intensity to increase with smaller visual angles, a possibility receiving some slight confirmation (not statistically significant) from data obtained with an additional, smaller (2°) angle presented to the last six of the 10 subjects tested.

Size Constant.

S_1: With r.p.m. constant at 120, duration scores increased from 1° to 2°, and then declined to the 4° angle (Figure 1c). The decline continued from 4° to 16°, a significant difference ($t=4.199$; $p<.01$) with r.p.m. at 75. As with duration scores, intensity ratings declined significantly ($t=5.618$, $p<.001$) from 4° to 16°, but did not differ significantly from the 1° to the 4° angles.

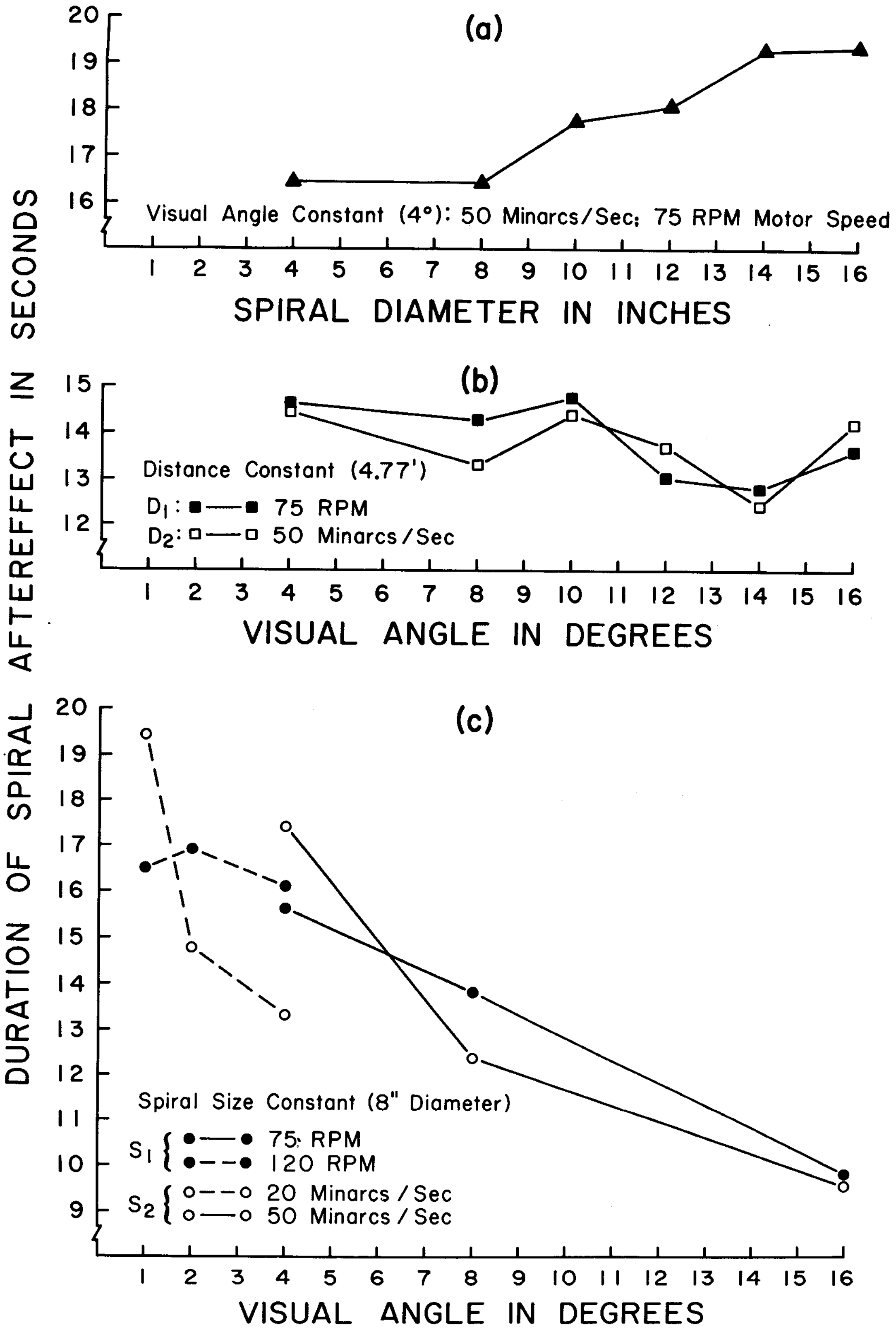

FIGURE 1. Durations of the SAE obtained from 10 subjects for the five experimental conditions. Note the peaking effect at the 2° visual angle in chart (c).

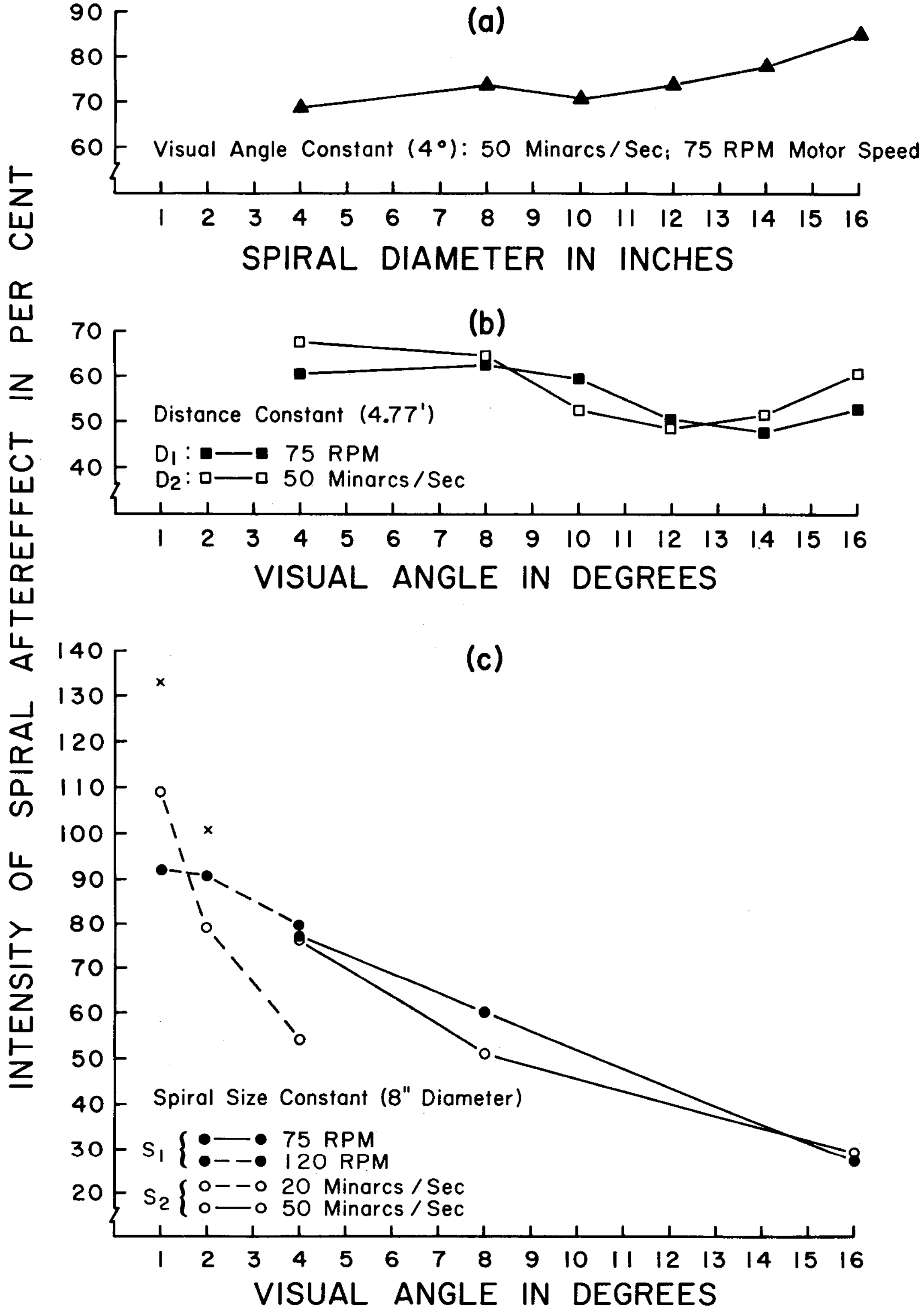

FIGURE 2. Perceived intensity of the SAE obtained for the five experimental conditions. All data points are based on 10 subjects with the exception of the 1° and 2° visual angles in the S_1 session of chart (c); these points are based on an N of 9. The subject excluded from these plots gave unusually high ratings to stimuli at these two angles; the two "X's" indicate the position of those points if the deviant subject is included in the means (i.e., for N=10).

Instead of a rise to a peak, intensity ratings showed a flattening from 1° to 2° and a drop to 4°. Extreme ratings of one subject, which markedly inflated the group mean intensity at the 1° and 2° angles were eliminated from the 120-r.p.m.-constant portion of this session (see Figure 2c).

S_2: With SEM constant, duration scores did not peak at 2° as they did in the S_1 session, declining instead from 1° through 4° ($t=3.474$; $p<.01$) with 20 minarcs/sec. constant, and from 4° to 16° ($t=5.251$; $p<.001$) with 50 minarcs/sec. constant (Figure 1c). Intensity ratings (Figure 2c) also showed a significant decrease from the 1° to the 4° angle ($t=2.933$; $p<.02$), and from the 4° to the 16° angle ($t=5.264$; $p<.001$). Thus, with SEM constant, SAE duration and intensity decreased steadily as a function of increasing visual angle (and of decreasing r.p.m.).

Retinal Speed

In general, holding retinal speed constant did not produce an effect different from that obtained by varying it widely, at least above 50 minarcs/sec. In S_1, retinal speed increased from 50 minarcs/sec. at 4° to 200 minarcs/sec. at 16°, but at no angle do these scores or ratings differ significantly from those obtained with retinal speed constant at 50 minarcs/sec. in S_2. Indeed, at the largest angle the data points for S_1 and S_2 (obtained at 200 and at 50 minarcs/sec. respectively) almost coincide on the figure, both for duration and for intensity (see Figures 1c and 2c). Similarly, with Distance Constant, a constant SEM (D_2) produced virtually the same function as that obtained where, with r.p.m. constant (D_1) it increased fourfold (Figures 1b and 2b).

Pre- and Post-Trials.

Pre- and post-trial group means and standard deviations are presented in Table 4. With duration scores, there is no progressive decline either within sessions or over sessions. With intensity ratings, however, within session declines were significant for the first three of the five sessions.

TABLE 4.—Means and standard deviations for the duration (in seconds) and rated intensity (in percent) for the standard spiral stimulus given to each subject in Pre- and Post-experimental trials at each session. Each value is based on two trials for each of 10 subjects unless otherwise indicated. The standard stimulus was an 8-inch spiral, rotating at 75 r.p.m., 9.55 feet from the subject.

Day		Duration			Intensity		
		Pre	Post	t	Pre	Post	t
1*	M	14.06	14.81	0.664	92.50	67.50	3.656***
	SD	2.93	4.00		8.78	18.03	
1	M	15.49			94.75		
	SD	5.49			8.03		
2	M	15.80	15.75	0.887	96.25	67.75	3.067**
	SD	6.11	7.55		8.10	26.79	
3	M	14.33	16.45	1.469	98.00	72.25	3.567***
	SD	7.54	10.73		3.29	23.55	
4	M	16.51	16.93	0.301	97.00	84.75	1.622
	SD	12.47	12.12		4.68	21.52	
5	M	14.21	14.02	0.134	97.50	73.20	2.051
	SD	10.28	11.81		4.08	35.79	

*Data for this day are based on 7 subjects. (No Post data were obtained for three subjects.)

**Significant beyond the .02 level.

***Significant beyond the .01 level.

IV. Discussion.

The SAE seems to vary in intensity as it does in duration in response to the experimental manipulations of this study, the plots of the two measures across visual angle or spiral size being generally parallel for each session (compare Figures 1 and 2). Wohlgemuth[18] reported similar results when judgments of duration and "vividness" both were studied—the latter not being quantified but merely expressed in terms of a given after-effect being "more" or "less" intense than a preceding one.

An exception to the similarity between the two measures is the statistically significant decline in intra-session intensity ratings of the "standard" stimulus from pre- to post-test for 3 of the 5 days, a decline not found with duration scores. Though SAE "strength" apparently decreased within some sessions, the decrement was not sufficient to alter the duration scores, as measured by the pre- and post-tests. Adequate spacing of trials apparently prevented habituation as well as fatigue effects from manifesting themselves in SAE duration scores.

Results of the five sessions seriously prejudice an assumption of either visual angle or retinal speed as the predominant influence on SAE measures. Manipulating visual angles produced results that differed according to the manner of variation (i.e., change of stimulus size or change of distance). At a given angle, wide differences in retinal speed produced no differential effect on SAE measures except possibly at low values. Further, where both visual angle and retinal speed were constant (A condition), there was a significant increase in aftereffect duration (Figure 1a) and a general increase in intensity ratings (Figure 2a) as stimulus size and distance were concomitantly increased. Other determinants must be operating.

Granit[9] found results identical to those of our A condition in an extension of his aftereffect experiment which yielded the peak in duration scores between 2° to 4°. He placed a reduction screen in front of the waterfall drum with a square window in it through which to observe the moving stripes. With varied window sizes of 12-, 9-, and 6-cm. square, he obtained a family of curves, each peaking between 2° and 4°, but ranged on the ordinate score according to window size, the larger windows producing consistently longer durations. At any given distance, then, there was a positive linear relationship for size and duration (a discrepancy from the peaking he obtained in each of the family curves). However, one may also adduce from these curves that at any visual angle, durations increased with size-distance increase, exactly the result of the A condition of the present study. (Costello[2] also reported the duration produced by a larger, more distant spiral as longer than that of a smaller, closer spiral subtending the same visual angle.)

To explain his discrepant results, Granit[9] mentioned that size constancy might be operating differently in the two test conditions. In the present study there were ample cues to distance in the texture density of the checkered floor and in the perspective lines formed by the ceiling and sides of the visual alley. On the basis of size constancy principles, it may be assumed that the subjects would have been aware of the changes in spiral size in the D_1 and D_2 sessions, of the constant size of the spiral (and changing distances) in the S_1 and S_2 sessions, and of the changes in both spiral size and distance in the A sessions. The results of this study may, therefore, be reinterpreted in terms of perceptual variables. In particular, the duration of the SAE appears to increase with increases in perceived size (S') per unit of retinal size (visual angle θ). This S'/θ ratio, a variable of long-standing interest in the visual perception work of Gogel,[5 6 8] is probably equivalent, in the present experiment (and under the usual form of the "size distance invariance hypothesis"), to perceived distance (Gogel's D'). If it is assumed that perfect size constancy occurred for the subjects in this experiment then, in the A session, with θ constant (4°) and S' increasing as spiral size was increased, S'/θ would also increase; thus, SAE durations were longer for larger values of S'/θ. In the D sessions, S'/θ would have been a constant (unity, i.e. 1) for each stimulus as spiral size and visual angle were concomitantly increased at a single distance; no significant change in duration scores would be predicted, then, from the smallest to the largest visual angle, and none occurred. In the S sessions, still assuming perfect size constancy, S' would have been constant with (8-inch spiral) while θ increased as the spirals were placed closer to the subjects. Thus, S'/θ would have increased from the largest to the smallest angles in the S sessions and, as in the D sessions, SAE durations increased with increases in S'/θ.

That an illusion might vary with certain perceived rather than physical characteristics of the stimulus receives support from the report of Gogel and Mershon[5] that the perceived whiteness contrast of two discs is influenced not only by a real displacement in depth between them but also by apparent or perceived displacement. What Gogel and Mershon[7] term "a relationship between perceptual events" may apply to the results of this study; i.e., the characteristics of aftermovement may be determined by the phenomenal, as well as by the retinal or physical dimensions of the stimulus. Additionally, Hildt and Van Liere[11] have reported longer SAE durations for "depth-cued" as opposed to "non-depth-cued" test figures.

The above paradigm, though hypothetical, neatly fits the result for all conditions except for the slight peak in duration scores in S_1 not found in S_2. This peaking (or flattening) effect at small visual angles is apparently a reliable phenomenon for an "r.p.m. constant" condition; it can be found in the data of Granit,[9 10] Pickersgill and Jeeves,[15] Fozard et al.,[3] and Collins and Schroeder.[1] Granit[9 10] explained the peak as reflecting an increase in the aftereffect with increased visual angle and retinal speed to the point (2° to 4°) where the rod receptors begin to predominate. The increasing rod density at larger visual angles was thought to inhibit cone function in a progressive fashion, thereby causing the steady decline in aftereffect measures as angle size was increased beyond 4°.

However, alternate explanations can be proposed which involve either a breakdown of size constancy at the greater distances or the possible influence of retinal speed at low values, i.e., below approximately 50 minarcs/sec. Increases in SEM from 50 to as much as 200 minarcs/sec. clearly produced no significant differential effect on SAE duration or intensity measures at various angles, either with *distance constant* or with *size constant.* Yet at the 4° angle in the S_2 session, where a direct comparison can be made of data for the same visual angle on the same experimental day, there is a difference in duration scores obtained with stimuli of 20 minarcs/sec. from those obtained with 50 minarcs/sec. that is considerable, though it does not reach significance at the .05 level.

If retinal speed change is an effective variable only at low rates (below, say, 40 to 50 minarcs/sec.), then the peaking phenomenon in S_1 may be due to a rise in SEM from 20 to 40 minarcs/sec. (from the 1° to the 2° visual angle), with the increase to 80 minarcs/sec. at 4° failing to overcome the natural trend of decreasing scores with increasing retinal size. The maintenance of a constant retinal speed within this "effective range" would then explain the failure of the peaking effect to appear in the S_2 session.

An interesting possibility is that the "speed effect" noted above may be actually one of perceived speed. That is, subjects may perceive increases in speed only below a fairly low critical value. This possibility is consistent with the suggested influence of perceived size and perceived distance upon the duration and intensity of the aftereffect.

Although the above explanations account for the present results, and several aspects of these data agree with comparable information in the studies of Granit[9 10] and of Collins and Schroeder,[1] there are also points of disagreement among the studies. Thus all of the just-noted studies show peaking or flattening effects and declining SAE durations with increased angle size in *size constant* (r.p.m. constant) plots of the data. The results of the *angle constant* condition of the present study agree with what may be adduced from the data of Granit,[9 10] but are inconsistent with those to be adduced from the data of Collins and Schroeder[1] (where, for two angles, a 16-inch spiral gave slightly shorter durations than an 8-inch spiral). The results of the *distance constant* condition approximate the findings of Collins and Schroeder[1] (some slight decline at angles larger than 10°) rather than those of Granit.[9 10] We have at present no clear explanation for these differences.

V. Summary.

The influence of visual angle and retinal speed upon the duration and intensity of the spiral aftereffect (SAE) was evaluated under five conditions: (a) *Angle constant* (A)—retinal speed and visual angle were held constant across a variety of spiral-size and viewing-distance combinations; (b) *size constant*—spiral size was held constant at a variety of distances and of visual angles, with retinal speed either varying (S_1) or held constant (S_2); (c) *distance constant*—several spiral sizes (visual angles) were employed at a constant distance with retinal speed either varying (D_1) or held constant (D_2). Duration and intensity measures were affected in a parallel fashion. The SAE scores increased significantly in A with increases in spiral size and distance, and decreased significantly—with the exception of a rise in duration scores from 1° to 2° in S_1—as angle size increased (and distance decreased) in the S conditions. But no significant effect was found at nearly the same visual angles in the D conditions. Perceptual rather than physical variables seem to account for the results. If it is assumed that perfect size constancy occurred during the experiment, then, in the A and the S sessions, SAE durations were longer for larger values of perceived size per unit of retinal size. Since the latter ratio would have been identical for all stimuli in the D sessions, no significant effect would be predicted across the various angles, and none occurred. Retinal speed variation produced no apparent effect, except possibly at low values. The fact that perceived (rather than physical) characteristics of the stimulus situation may have the most significant effects on the duration of illusory motion has considerable pertinence to the evaluation of effective factors in the production of a variety of other visual illusions which can occur in aviation environments.

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