Notes and Comment

Prism adaptation with hypnotically induced limb anesthesia: The critical roles of head position and prism type

BENJAMIN WALLACE and LESLIE E. FISHER
Cleveland State University, Cleveland, Ohio

Recently, Spanos and his colleagues (Spanos, Dubreuil, Saad, & Gorassini, 1983; Spanos, Gorassini, & Petrusic, 1981) reported two failures to replicate a phenomenon involving hypnotic anesthesia which has been reported by our laboratory and by that of others (Wallace & Fisher, 1979; Wallace & Garrett, 1973, 1975; Welch & Snyder, cited in Welch, 1978, p. 27). The phenomenon involves adapting to prism displacement when hypnotic anesthesia is present in an adapting limb. Specifically, when subjects are asked to observe arm movement through displacing prisms and to adapt to the displacement, they can easily accomplish this if they are able to experience normal arm sensations during the adaptation process (Harris, 1965; Kornheiser, 1976). However, if proprioceptive feedback and felt arm sensations are disrupted as a result of inducing hypnotic anesthesia in the adapting limb, subjects fail to adapt to the prism displacement. We have argued that such anesthesia disrupts proprioceptive feedback from the arm and, as a result, adaptation does not occur (e.g., Wallace & Fisher, 1979).

Spanos et al. (1981) failed to replicate our effect; that is, they reported that adaptation to prism displacement occurs regardless of whether subjects are asked to perform a task with hypnotic anesthesia in the adapting limb or without it. However, as we have previously argued (Wallace & Fisher, 1982), Spanos et al. (1981) introduced a situation during prism exposure that overrode the effect of the hypnotic anesthesia. If a visual target is present to which subjects point during prism exposure, this provides individuals a reference point. This would enable them to visually guide the limb in question toward the target on each and every trial and would result in their receiving error-corrective feedback (Welch, Choe, & Heinrich, 1974). With such feedback, the proprioceptive decrement, which develops as a result of hypnotic anesthesia, becomes irrelevant, inasmuch as visual information is employed in adapting to the visual displacement. In other words, when a target is present during prism exposure (as it was for Spanos

et al., 1981), adaptation would still occur even if the adapting arm was hypnotically anesthetized. When the visual target is absent, as it was in the Wallace and Fisher (1979) study, visual guiding and error-corrective feedback are not possible, and subjects must rely upon proprioceptive feedback to adapt. When this feedback is not possible because of the introduction of hypnotic anesthesia in the adapting limb, adaptation does not occur.

Spanos et al. (1983) have recently argued that the target-absent versus target-present dimension is not the critical factor in determining whether subjects adapt to a prism displacement when hypnotic anesthesia is administered in the adapting limb. Instead, they argue that their inability to replicate our experiments is the result of other factors. Specifically, in employing an exposure situation in which subjects can see the consequences of their arm movement only at the terminus of the movement, they found that individuals, especially those who had received hypnotic anesthesia in the adapting limb, often reached for a visual target or toward the position they deemed to be "straight ahead of their noses" in such a way as to not see the reach. That is, the arm was down so low during the reaching motion that they did not see the arm movement during the reach and also did not see it at the terminus of the reach, when they were supposed to observe the arm. Spanos et al. (1983) also observed that when the consequences of the prism exposure were determined during the postexposure assessments, their subjects were often correcting their reaching motions in midpath. When they began the reach toward a visual target, they would exhibit what appeared to be adaptation to prism exposure. However, as they continued the reach, they corrected for the observed error in the path and reached for the target in a veridical manner. This, of course, resulted in the elimination of perceptual adaptation.

While it is possible that what Spanos et al. (1983) found can explain the reason for their failure to confirm our findings, it is also possible that other procedural differences may exist between our studies and those of Spanos et al. When we assess adaptation to prism displacement, Risley rotating prisms are employed which subjects wear for the duration of their participation. Without ever removing these prisms, which are encased in welder's goggles, the subjects participate in a preexposure phase (with no prism displacement), an exposure phase (with a 20- or 30-diopter displacement), and a postexposure phase (with no prism displacement). Spanos et al. employed displacing prisms but not the nonremovable, Risley rotating variety. Because of this, the experimenter must physically remove the goggles from the subject's eyes whenever there is a change in the

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phase of the adaptation paradigm. In so doing, it is quite conceivable that the experimenter might move the subject's head just enough to create a condition for producing what may be misconstrued as prism adaptation. Thus, if a subject's head is turned from its original, preexposure orientation, the position "straight ahead of the nose" changes, as might the subject's orientation toward a visual target, depending upon what a subject is to localize during the adaptation situation. As a result, instead of Spanos et al.'s subjects' adapting to prism displacement, even when hypnotic anesthesia was present, these individuals may inadvertently have been moved so that their head positions and orientations were shifted in the adaptive direction. In fact, by employing removable, displacing prisms instead of Risley prisms, measurement bias can be quite prevalent (see Harris, 1974; Paap & Ebenholtz, 1976). To determine if a measurement bias could have existed in the Spanos et al. (1983) study, the effects of goggle removal on subsequent head position during phases of the adaptation paradigm, with and without hypnotic anesthesia, were explored in the following experiment.

METHOD

Subjects

Twenty-four right-hand-dominant undergraduate volunteers from introductory psychology classes served as subjects. Twelve were selected for having scored high (9-12) on the Harvard Group Scale of Hypnotic Susceptibility, Form A (Shor & Orne, 1962). The remaining subjects were chosen for having scored low (0-3) on the test.

Apparatus

The apparatus was similar to that employed by Wallace and Fisher (1979). This structure consisted of a three-layer, rectangular wood frame (77 cm high, 62 cm wide, and 62 cm deep) open on the side facing the subject. When a subject placed his or her dominant arm within the structure, on the lowest layer, it was not visible. In this area, during the preexposure and post-exposure phases, arm position could be noted by an experimenter by determining its location along a 180-deg arc, calibrated in 1-deg increments. During the exposure phase, placement of the subject's arm upon the center layer permitted the individual to perceive arm movement only at the terminus of a response action. Observation of arm movement throughout most of the exposure session was prevented by a third layer, located 12 cm directly above the second layer of the apparatus. During the exposure phase, all visible surfaces were homogeneous in appearance; that is, there were no visible targets toward which the subject could localize arm movements. Attached to the apparatus was a combination head- and chinrest. A piece of tape with individual degree increments of an arc was attached to the chinrest.

Procedure

The subjects were individually tested by being led to an experimental room and seated in a chair before the apparatus. Risley prisms, set to 0 diopter (no prism displacement) and mounted in welder's goggles, were then placed over the subject's eyes. The subject's head was then positioned in the chinrest, and a piece of tape was attached to his or her chin. Upon this piece of tape was a vertical line that was aligned with the 0-deg increment mark on the piece of tape located on the chinrest. This alignment was such that the subject's head was positioned in a straight-ahead gaze. The subject then placed his or her right arm on the lowest layer of the apparatus and pointed to the

position in space that he or she believed to be straight ahead of his or her nose. This task was accomplished without sight of arm movement and with constrained head movement. During this preexposure, baseline determination, the straight-ahead localization task, was performed three times.

Following the establishment of the preexposure baseline, 12 subjects who were judged to be high on the attribute of hypnotic susceptibility had their right arms hypnotically anesthetized. These individuals were sufficiently informed for the task with respect to the consequences of induced, hypnotic anesthesia. They were told that the arm would feel totally numb and absent of all sensations (see Wallace & Hoyenga, 1981, for the exact instructions and procedure). If subjects scored low on the attribute of hypnotic susceptibility, they were requested to role-play being hypnotized and having the limb feel hypnotically anesthetized. Success of the hypnotic anesthesia manipulation was determined by requesting the subject to point to his or her nose with eyes closed. The ability to perform this simple, proprioceptive task has been shown to be affected by the implementation of hypnotic anesthesia in the pointing limb. When this manipulation is in effect, the subject either misses the nose location or shows a prolonged response time between movement initiation and nose localization (Wallace & Hoyenga, 1981). Only hypnotically anesthetized subjects responded in error to the nose-touch task.

After the anesthesia induction (real or role-played), the experimenter set the Risley prisms to 20 diopters, base right. The subject was then requested to point straight ahead of his or her nose. Pointing was performed in a ballistic fashion, such that subjects extended the right arm away from the body and then brought it back. This back-and-forth action was performed approximately 55 times within a 3-min exposure period. During the exposure, head movement was constrained, and therefore the consequences of the pointing were perceived only at the terminus of the action.

Following prism exposure, the goggles were either removed from the subject's head (as in the Spanos et al., 1983, procedure) or were left on the head (as in the Wallace & Fisher, 1979, procedure). If the goggles were removed, this was accomplished from the subject's right side. This position was chosen because, if our assumption was correct and Spanos et al. (1983) did have goggles removed from the subject's right side, this would produce the effect they reported. This would especially be the case if the right side became a standardized and systematized position from which goggles were removed. This would not be unusual inasmuch as most laboratories standardize experimental procedures.

If Spanos et al. did systematize goggle removal, this would result in their subjects' nose orientations being shifted in the adaptive direction (the direction opposite prism displacement; Harris, 1965). Goggle removal from the subject's left side or from directly in front of or behind the subject would not have produced a head position reorientation in the adaptive direction.

If the goggles were not to be removed, the subject closed his or her eyes while the experimenter recalibrated the prisms to 0 diopter (as in the preexposure phase). After this, the subject was instructed to open his or her eyes, and the hypnotic anesthesia (real or role-played) was removed. The subject was then asked to perform the nose-touch task. All individuals responded in a veridical manner to this request. The subjects were then requested to perform three times the task used in the preexposure period. Level of adaptation as specified as the signed difference between mean preexposure and postexposure localization measures.

RESULTS

A preliminary analysis of the data failed to produce a significant trials effect for the localization task. Subsequent analyses were therefore restricted to the averaged

difference score between preexposure and postexposure pointing to the straight-ahead position. These difference scores were subjected to an analysis of variance in which anesthesia (absent or present) was found to be a significant factor [$F(1,20) = 211.17, p < .001$]. Goggle removal also had a significant effect on adaptation [$F(1,20) = 188.71, p < .001$]. The interaction of anesthesia $\times$ goggle removal was not significant [$F(1,20) = 2.20$].

The magnitude of adaptation for the four conditions were as follows: anesthesia with goggle removal, mean = 2.23 deg, SD = 0.22; anesthesia with no goggle removal, mean = 0.63 deg, SD = 0.42; no anesthesia with goggle removal, mean = 4.39 deg, SD = 0.33; and no anesthesia with no goggle removal, mean = 2.05 deg, SD = 0.82. Dependent-measure *t* tests applied to preexposure-postexposure difference scores indicated that only the anesthesia with no goggle removal condition was not significantly greater than zero.

Measurable postexposure head shifts were found to exist for both goggle removal conditions. The mean shifts for the anesthesia present and anesthesia absent conditions were 1.53 deg (SD = 0.55) and 1.61 deg (SD = 0.58), respectively. Also, the difference between these means was not found to be significant ($F < 1.00$). Significant head shifts were absent for the two conditions in which goggle removal did not take place. The mean shifts for the anesthesia present and anesthesia absent conditions were 0.30 deg (SD = 0.24) and 0.25 deg (SD = 0.32), respectively. Head shifts resulting from goggle removal were also significantly correlated with magnitude of adaptation [$r(22) = .66, p < .001$].

DISCUSSION

It appears that goggle removal may have played a role in producing the type of "adaptation" reported by Spanos et al. (1983). In fact, goggle removal from the right side of the subject resulted in the production of "adaptation" at a level that significantly exceeded what would be produced by leaving the prisms over the subject's eyes for postexposure assessments (which is possible only with Risley prisms).

Spanos et al. (1983, p. 218) report that, averaged over all conditions, subjects showed 6.85 deg (SD = 3.13) adaptation. When considering only subjects who were hypnotically anesthetized, 5.42 deg (SD = 2.54) adaptation was produced. These values differ from ours in two respects: the mean values are larger and so are the measures of variability. With our values of variability being considerably smaller (< 1.00) in all conditions, it is not surprising that Spanos et al. failed to find the difference we have reported on numerous occasions (e.g., Wallace & Fisher, 1979; Wallace & Garrett, 1973, 1975). However, it should be noted that Spanos et al.'s data were in the direction we predicted, although not significantly so. Thus, if their overall adaptation mean was 6.85 deg and hypnotically anesthetized subjects

showed 5.42 deg adaptation, one must conclude that nonanesthetized subjects showed about 8.30 deg adaptation. And, although these mean values differ by 2.88 deg, they are not significantly different (the variance for the 8.30 value is not reported, but it must have been large for the aforementioned difference not to be significant). Our results are similar, except that the adaptation difference between our anesthetized and nonanesthetized subjects was significant, the result of a much smaller variance than in the Spanos et al. study. Spanos et al. do not report if their adaptation values were significantly greater than zero. We assume they were. However, if one corrects their values by the possible postexposure head shift, adaptation may not have been significant in the anesthesia condition, especially given their large variance value.

With Spanos et al. reporting nonsignificant results but in the direction we report here, it would appear inaccurate for them to claim that this constitutes a failure to replicate our earlier studies. With the large difference between our respective adaptation variances, it would seem prudent to determine why this occurred.

Other differences were noted between the results produced by our laboratory and that of Spanos et al. They reported that during prism exposure and adaptation, subjects were observed to make midpath corrections (Spanos et al., 1983, p. 219); we noted no such behavior. Also, the adaptation magnitude reported by Spanos et al. for 20-diopter displacement exceeded what we typically find being produced in our laboratory and that of others (Choe & Welch, 1974; Redding, 1978). In light of the effect of postexposure goggle removal on adaptation magnitude, Spanos et al.'s findings do not appear surprising. A portion of their adaptation magnitude may have been artifactual.

Spanos et al. (1981, 1983) also confirmed (and statistically so) the finding first reported by our laboratory that the presence of hypnotic anesthesia is related to a failure to perform the nose-touch task in a veridical manner. Unlike the reports of Spanos et al., all of whose anesthetized subjects failed to accurately find their noses, we find either what Spanos et al. reported or that subjects do find their noses but that it takes them longer to do so when their limbs are anesthetized than when they are not. We were puzzled as to why none of Spanos et al.'s subjects made the second type of reaching error. Finally, related to this, we were also concerned as to why Spanos et al. found that subjects made a proprioceptive error when their limbs were anesthetized (i.e., they failed the nose-touch task), but that, when measured on a second proprioceptive task (prism adaptation), they appeared to exhibit 100% decay of the anesthesia effect (proprioceptive decrement).

It is important that experiments involving hypnotic manipulations be replicated and that previous results be confirmed. However, it is equally as important that critical procedures be maintained in seeking confirmation. We believe Spanos et al. (1981, 1983) failed to do this.

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