To: pdasilva@mail.arc.nasa.gov
Subject: Fwd: Re: NCC 2-529 - Dr. Stoper's final technical report
Cc: Barrie Caldwell <bacaldwell@mail.arc.nasa.gov>

Paula,
Here is the final report for NCC 2-529. tx, Barrie
****

>Date: Fri, 10 Dec 1999 14:11:39 -0800
>To: Barrie Caldwell <bacaldwell@mail.arc.nasa.gov>
>From: Malcolm Cohen <mmcohen@mail.arc.nasa.gov>
>Subject: Re: NCC 2-529 - Dr. Stoper's final technical report
>
>Dear Barrie -
>
>I asked Dr. Stoper to send me a Final Technical Report, and he has now done
>so. I believe that his report is more than adequate, and that he has
>provided us with an excellent summary of his accomplishments under NCC2-529.
>

>Malcolm M. Cohen, Ph.D.
>Mail Stop 239-11
>NASA Ames Research Center
>Moffett Field, CA 94035-1000
>
>tel: (650) 604-6441
>fax: (650) 604-3954

"It is not enough to be busy...
The question is:
What are we busy about?"
-Thoreau

Recd
DEC 28 1999
CC: 202A-3
CASI

> &&&&&&&&&&&&&&&&&&&&&&&&&&&&&
>The contents of his report follows:
>
>Final Technical Report
>NASA AMES agreement NCC 2-529,
>Gravitational and Optical effects on Perceived Location and Orientation.
>Principal Investigator: Arnold E. Stoper
>Period 7/1/95 to 6/3/98
>
>During the period of this grant I gave 5 oral presentations, published one
>paper, and have several others in the process of preparation. I will present
>here abstracts of these studies, and indicate what I believe to be their
>significance to the understanding of gravitational and optical effects on
>perceived location and orientation
>
>1. The effect of environmental pitch on apparent zenith. With Justin Randle,
>presented at the Meeting of the Psychonomic Society, Nov. 12,1995, Los
>Angeles, and at Oxyopia, UC Berkeley, Dec. 1, 1995
>Supine observers set a target to apparent zenith while looking up into a
>chamber which was pitched 20 deg. up, level, and 20 deg. down. They then tried
>to point to the location of that target with an unseen hand. The 40 deg.
>total shift in pitch of the chamber produced nearly a 30 deg. shift in
>apparent zenith, but pointing was accurate. A previous analogous experiment
>with erect observers produced only a 19 deg. shift in eye level.

>
>Significance
>The finding of increased shift of apparent zenith (increase in capture) in
>supine position is consonant with the previous finding (Stoper and Cohen,
>1991) that when S attempts to judge HREL (head relative eye level) while
>lying on his side the effect of pitched optical structure is much greater
>than when S is erect. The increase in capture for non-erect posture could
>be explained as a decreased reliance on the otolith system. Thus, when
>posture is non-erect, more weight would be given to optical information
>relative to gravitational information.
>
>There is conflicting evidence as to the effect of environmental pitch on
>open loop pointing with erect posture. Cohen and Ballanger (1989) have
>demonstrated that there is a small (about 25% of boxpitch magnitude) but
>consistent open loop pointing error for an erect S produced by environmental
>pitch. However, others (Stoper, Fries, and Bautista, 1992) have found an
>even smaller (about 4% of boxpitch) pointing error
>
>It might be expected that the increase in judgment error produced by supine
>posture would be accompanied by an increase in open-loop pointing error.
>The present experiment, on the contrary, found no significant pointing error
>in the supine condition. The implication of this result is that the judgment
>error and open-loop pointing error are produced by independent mechanisms.
>
>2. The effect of environmental pitch on perceived optic slant and eye level:
>lines vs. dots. Presented at European Conference on Visual Perception
>Strasbourg, France, 1996)
>
>Visually perceived eye level (VPEL) has been shown to be strongly affected
>by the pitch of the visible environment (Stoper and Cohen, 1989 Perception &
>Psychophysics 46 469 -- 475), even if this environment consists of only two
>luminous lines pitched from the vertical (Matin and Li, 1992 Journal of
>Experimental Psychology: Human Perception and Performance 18 257 -- 289).
>Here, two luminous vertical lines or 32 randomly distributed luminous dots
>were mounted on a plane that was viewed monocularly and was pitched (slanted
>in the pitch dimension) 30° forward or backward from the vertical. In
>addition to measuring the VPEL, we measured the perceived optic slant
>(rather than the perceived geographic slant) of this plane by requiring each
>of our ten subjects to set a target to the visually perceived near point
>(VPNP) of the plane. We found that, for the lines, VPNP shifted 50% and VPEL
>shifted 26% of the physical pitch of the plane. For the dots, VPNP shifted
>28% but VPEL shifted only 8%. The effect of the dots on VPEL was weaker than
>might have been predicted by their effect on VPNP, which was used to
>indicate perceived optic slant. The weakness of the effect of the dots on
>VPEL implies that changes in VPEL result from a direct effect of the stimuli
>on VPEL, rather than one mediated by the perceived optic slant of the plane.
>The non-zero effect of the dots shows that pitched from vertical line
>segments are not necessary to shift VPEL.
>
>Significance

>This experiment is addressed to the question of the mechanism underlying the
>effect of environmental pitch on perceived eye level (called here VPEL, but
>synonymous with GREL). Matin's "great circle theory" of this effect assumes
>that it is due to pitched from vertical lines, and that those lines act
>directly on VPEL rather than act through perceived pitch (slant) of the
>environment. The present experiment contradicts this theory in part, but
>also supports it in part. The contradiction is the evidence that a surface
>composed of just random dots has any influence at all on VPEL. The support
>is that there seems to be a dissociation of perceived slant of a surface
>from the influence of that surface on VPEL. This implies an independence of
>the mechanism that produces perceived slant from the one that produces the
>VPEL shift, as Matin would predict.
>One important aspect of this experiment is the method used to measure
>apparent slant of a surface. There are two distinct types of slant:
>geographic, which is the angle between the surface and some external
>reference such as gravity, and optic, which is the angle between the surface
>and the line of sight to that surface. The slant of importance here is
>optic slant, since it is optic slant that would be changed by manipulation
>of optic variables. It does not make sense, however, to have the subject
>give some estimate of perceived optic slant of a surface, as has been done
>in some experiments investigating this variable. This is because optic slant
>varies continuously over a plane surface, which has some fixed geographic
>slant.
>The method used in the present experiment to measure perceived optic slant
>was to have the subject estimate the "near point" of the surface; i.e., the
>point of the surface which is apparently the closest to the subject. This
>near point specifies the optic slant of the entire surface. To my knowledge,
>this method has never been used before.
>
>3. Environmental pitch and three types of pointing Presented at European
>Conference on Visual Perception, Helsinki, Finland, 1997
>Many studies have shown that large errors are made when setting a target (T)
>to visually perceived eye level (VPEL) in a pitched environmental surround.
>The error in judgment of VPEL is typically about 50% of the environmental
>pitch angle. An observer can, however, point to the level of the target (T)
>with much smaller errors (e.g.,. Stoper et al, 1992 Bulletin of the
>Psychonomic Society 30 439, found a shift of pointing of only 4% of the
>environmental pitch). These small pointing errors are found when the
>observer reaches out with an unseen hand and touches the surface on which T
>is presented. We call this `type I pointing'. If longer distances (183 cm)
>are used the observer must walk (with closed eyes, as in `pin the tail on
>the donkey') in order to touch the surface on which T is presented. We call
>this `type II pointing'; it results in much larger errors, approaching in
>angular magnitude the errors in judgment of VPEL.
>In the present experiments the observer indicated the level of T by touching
>a point on an unseen pole which was just to the right of the observer's eyes,
>and thus separated from T by the viewing distance [as in the `manual task'
>used to judge apparent height by Stoper and Bautista (1992 Investigative
>Ophthalmology and Visual Science, Supplement 33 962)]. We call this `type
>III pointing'. This method, for both long and short distances, produced

>large errors similar in magnitude to those of type II pointing. These
>results are explained by the assumptions that environmental pitch causes an
>error in the judgment of the apparent horizontal in the sagittal plane
>(sagittal apparent horizontal; SAH) and that SAH is used in pointing of
>types II and III, but not of type I.
>Significance
>There is a rapidly growing literature on open loop pointing when an illusion
>of judgment is introduced by altering optical or gravitational environment.
>This literature is conflicting as to the size of open-loop pointing errors
>produced by such alterations. This set of three experiments is intended to
>explain some of the sources of conflict. These experiments show that there
>are at least three distinct types of open-loop pointing, and the size of the
>pointing error depends on the type of pointing. They also show dissociation
>between pointing error and error in judgment in locating a target. Thus,
>under some circumstances it is possible to get a large judgment error but a
>vanishingly small open-loop pointing error. If, however, the experiment
>conditions are such that pointing depends on judgment of subjective
>horizontal, any error in judging the subjective horizontal will produce a
>pointing error. This is the case when the observer points to the apparent
>level of the target with his hand close to his body (type II pointing), and
>also when the observer must walk with closed eyes to the target, and then
>point to it (type three pointing).
>
>4. Height and extent: Two kinds of size perception. Presented at Festschrift
>for Ulric Neisser, Emory University, Atlanta, Nov. 15,1996
>
>5. Visual Perception at the Mystery Spot. Oral presentation (invited) October
>23, 1998 at the Cognitive Psychology Colloquium of University of California,
>Berkeley
>
>6. Height and extent: Two kinds of size perception" Ecological Approaches to
>Cognition: Essays in Honor of Ulric Neisser. 1998, in E. Winograd, R. Fivush,
>& W. Hirst (Eds.). Hillsdale, NJ: L. Erlbaum
>
>Significance
>These three papers are an elaboration of previously presented data
>concerning a size illusion observed at the "Mystery Spot".
>The Mystery Spot is one of about 30 roadside attractions in the US, which
>feature various illusions produced by distorted buildings and sloping
>terrain. Most of these illusions can be explained fairly easily in terms of
>an induced misperception of gravitational vertical and horizontal; but one
>of them, the "plank illusion", is not so easily explained. The plank
>illusion occurs when two observers stand at opposite ends of a level plank,
>about one-meter in length. The plank is on a level plateau on otherwise
>steeply sloping terrain, so that one observer stands on the uphill side, the
>other on the downhill side. The observers judge each other's size, and when
>they reverse position their relative size seems to change dramatically.
>We (Stoper and Bautista, 19--) have studied this illusion in a laboratory
>setting, which consists of the observer standing inside of, and looking
>into, a 185-cm long chamber that can rotate in the pitch dimension. (The

>"pitch box") The tasks were to set a point at "gravitationally relative eye
>level" (as would be determined by a carpenter's level) and using various
>strategies to judge the size of a target objects standing on the floor at
>the far end of the box. This was done with the pitchbox pitched up 15 deg.,
>level, and down 15 deg. Apparent eye level was shifted by about 63% of the
>box rotation, in the direction of that rotation.
>When the observer matched the apparent size of the target object by means of
>a variable object (the matching task) there was a significant effect of box
>pitch, but it was surprisingly small. A much larger effect (total shift of
>42 cm in the apparent size of a 152 cm target) was found when the observer
>indicated the height of the top of the object with an unseen hand (the
>manual task).
>
>The explanation offered for these observations, as well as the plank
>illusion, is in terms of a misperception of an "implicit ground" and the use
>of a "height strategy" rather than the more usual "extent strategy" for
>judging size.
>
>I believe that this approach is a new one in the field of size perception,
>and accounts for the evident connection between errors in judgment of
>gravitational direction and errors in judging size.
>
>References
>Cohen, M. M. (1973). Elevator Illusion: Influences of otolith organ
>activity and neck proprioception. Perception and Psychophysics, 14,
>401-406.
>
>Cohen, M. M. & Larson, C. A. (1974). Human spatial orientation in the
>pitch dimension. Perception and Psychophysics, 16, 508-512.
>
>Gibson, J. J. & Cornsweet, T. (1952). The perceived slant of visual
>surfaces - optical and geographical. Journal of Experimental Psychology,
>44,11-15.
>
>Howard, I. P. (1982). Human visual orientation. New York: Wiley.
>
>Kleinhans, J. L. (1970). Perception of spatial orientation in sloped,
>slanted and tilted visual fields. Ph.D. Dissertation, Rutgers University,
>New Jersey.
>
>MacDougall, R. (1903). The subjective horizon. Psychological Review
>Monograph Supplement, 4, 145-166.
>
>Matin, L., Fox, C.R., and Doktorsky, Y. (1987) How high is up? II. Invest.
>Ophthalmic and Visual Science, 26, Apr. Suppl., p. 300.
>
>Matin, L., Fox, C.R.(1988) Visually perceived eye level and perceived
>elevation of objects: linearly additive influences from visual field pitch
>and gravity.
>

>Mittelstaedt, H. (1984). The effect of visual on extraretinal information
>about the vertical: Suppression or superposition?. Paper presented at the
>XXIII International Congress of Psychology, Acapulco, September 3, l984.
>
>Rock, I., Goldberg, J., and Mack, A.,(1966) Immediate correction and
>adaptation based on viewing a prismatically displaced scene. Perception and
>Psychophysics, 1, 351-354.
>
>Schone, H. (1964). On the role of gravity in human spatial orientation.
>Aerospace Medicine, 35, 764-772.
>
>Shebilske, W. L. (1981). Visual direction illusions in everyday
>situations: Implications for sensorimotor and ecological theories. In D. F.
>Fisher, R.A. Monty & J. W. Senders, Eds., Eye Movements: Cognition and
>Visual Perception, (pp. 95-110) Lawrence Erlbaum Associates.
>
>Stoper, A.E. and Bautista, A. Apparent height as a function of pitched
>environment and task" Investigative Ophthalmology and Visual Science
>Supplement, 1992, Vol. 33, No 4, p962
>
>Stoper, A.E., and Cohen, M.M. (1986)Judgments of eye level in light and
>darkness. Perception and Psychophysics, 40(5), 311-316.
>
>Witkin, H. A., (1949). Perception of body position and of the position of
>the visual field. Psychological Monographs: General and Applied, 63 (7)
>, 1-46.
>
>Witkin and Asch, (1948)Studies in space orientation: IV. Further studies of
>the perception of the upright with displaced visual fields. Journal of
>Experimental Psychology, 38,762-782.
>
>Witkin, H. A. & Wapner, S. (1950). Visual factors in the maintenance of
>upright posture. American Journal of Psychology, 63, 31-50.>Hi, Mal,
>
>
>&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&&
> >Mal,
> >Have you received a final summary of research for this agreement
> >with CAL State Hayward and Professor Arnold Stopper?
> >
> >Thank you,
> >Barrie A. Caldwell
> >bacaldwell@mail.arc.nasa.gov
> >(650) 604-5802 FAX -4646
> >http://server-mpo.arc.nasa.gov/grants/index.html
> >http://www.arc.nasa.gov/