Chapter # 1.

Natural visual scenes contain several independent sources of information (cues) about a single property such as slant. It is widely assumed that the visual system processes such cues separately and then combines them with an averaging operation that takes the reliabilities of the individual cues into account. Does that mean that people lose access to information about inconsistencies between the cues, or are all inconsistencies revealed in a distorted surface appearance? To find out, we let observers match the slant and appearance of a simulated test surface to those of an identical, simultaneously visible, simulated reference surface and analyzed the variability in the settings. We also let observers match surfaces under conditions that were manipulated in ways that were expected to favor certain cues (monocular or binocular) or to selectively disrupt certain comparisons between the surfaces (slant or structure). The patterns in the variability between the settings were consistent with predictions based on the use of all available information. We argue that information about discrepancies is only “lost” during cue combination if there is no benefit in retaining the information.

Chapter # 2.

Weighted averaging is said to be optimal when the weights assigned to the cues minimize the variance of the final estimate. Since the variance of this optimal percept only depends on the variances of the individual cues, irrespective of their values, judgments about a cue conflict stimulus should
have the same variance as ones about a cue consistent stimulus. We tested this counter-intuitive prediction with a slant matching experiment using monocular and binocular slant cues. We found that the slant was indeed matched with about the same variance when the cues indicated slants that differed by 15 degrees as when they indicated the same slant.

Chapter # 3.

The visual system uses multiple complementary sources of information (cues) to estimate properties of interest. The advantage of doing so is that errors in the estimates from different cues for the same property will be slightly different, so that a weighted average of the cues can provide the best overall estimate. It is known that cues’ weights are based on their reliability, but it is not known whether this reliability is determined for each region of a scene or for each object of the scene. We show that weights of cues for surface slant are determined for each object. This implies that weights are assigned only after object boundaries have been identified.

Chapter # 4.

When several cues provide information about the same property of a visual scene, a weighted average of the single-cue estimates can provide a more reliable estimate than that of any individual cue. Some cues rely on assumptions about the scene. A well-known assumption is that shapes are isotropic, so that an elliptical image is interpreted as a circle which is viewed at an angle. This study investigates whether the weight of image shape as a slant cue can be manipulated by providing evidence for or against the circularity assumption. Providing direct evidence that the object in question was circular slightly
increased the weight assigned to image shape, with respect to the weight given to other information about slant such as the gradient of binocular disparity. Whether circles or ellipses surrounded the object did not influence the weights. Thus the weights are not completely insensitive to the prevailing circumstances, but the influence of the context is modest at best.