

Midterm test #2

Time permitted: 90 minutes

A. Facts

Answer all of the following questions. Each question is worth two marks.

1. Name one absolute metrical depth cue.

vergence, accommodation, familiar size

2. What is the Vieth-Müller circle?

the circle that passes through the two eyes and the fixation point

3. Name three Gestalt grouping rules, and give an example of each.

good continuation, similarity, proximity, parallelism, symmetry, common region, connectedness

4. What is an accidental viewpoint?

a viewpoint that produces a regularity in the image (e.g., a connected line, a straight edge) that is not present in the world

5. What is a receiver operating characteristic (ROC) curve?

a plot of hits versus false alarms (at various criterion levels)

6. Define sensitivity (d') and bias, as these terms are used in signal detection theory.

Sensitivity is the observer's ability to discriminate between different stimuli, measured in a way that does not depend on response bias.

Alternatively, sensitivity is the distance between the signal-absent and signal-present distributions of the observer's internal responses (i.e., decision variable).

Bias is the observer's tendency to give one response more often than the other.

7. Name the cells where sound vibrations are converted into neural signals.

inner hair cells

8. What is the range of (a) frequencies and (b) intensities that a normal human auditory system can process? Give lower and upper limits, and specify the units.

frequency: 20 – 20,000 Hz

intensity: 0 – 120 dB

B. Explanations

Answer any two of the following three questions. Each question is worth ten marks.

Be sure to explain your answers as well as you can.

1. Sketch and label a diagram of the outer, middle, and inner ears, labelling the following parts: outer hair cells, tympanic membrane, tectorial membrane, tympanic canal, malleus, stapes, round window, oval window, incus, vestibular canal, middle canal, basilar membrane, Reissner's membrane, inner hair cells, pinna.

see Figures 9.10 and 9.11

2. Draw a diagram to illustrate binocular disparity, as follows. Draw two eyes fixating a single point F. Draw the horopter. Draw a point C with crossed disparity. Draw a point U with uncrossed disparity. Show the locations of the images of points F, C, and U on the two retinas.

see Figures 6.24 and 6.27

3. Explain how the Pandemonium theory of letter recognition avoids some of the problems of naïve template theory.

Naïve template theory suggests that we store templates for every object we can recognize. New images are matched point by point against stored templates, and identified according to which template is most similar. The most serious problem with this theory is that objects look very different from different points of view and under different lighting conditions, so in order to recognize objects this way we would have to store an implausibly large number of templates.

The Pandemonium theory avoids this problem by using features that do not change very much across viewpoints or lighting conditions. This theory suggests that we detect a small number of simple features in an image, like straight or curved line segments, and that we use this information (i.e., which features are present or absent) to identify letters. Because the features do not vary across viewpoints and lighting conditions, we would not need a very large number of stored representations in order to identify letters this way.

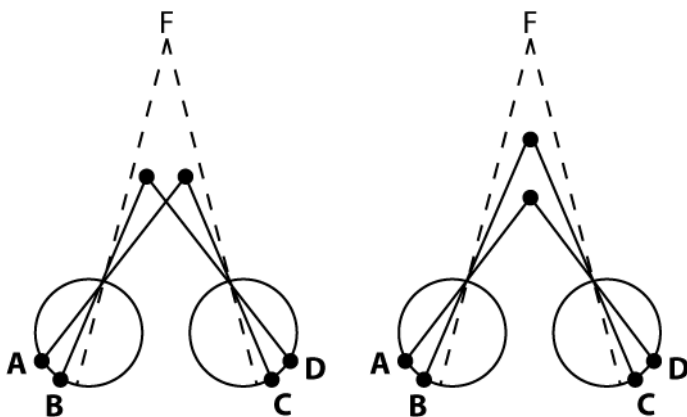
C. Problems

Answer any two of the following three questions. Each question is worth ten marks.

Be sure to explain your answers as well as you can.

1. (a) What is the correspondence problem for binocular vision? (b) Illustrate the correspondence problem as follows. Sketch two eyes, viewed from above, fixating a point F. Put two dots on the left retina and label them A and B. Put two dots on the right retina and label them C and D. The observer's visual system might assume that A corresponds to C and B corresponds to D. Alternatively, it might assume that A corresponds to D and B corresponds to C. Show why the observer's 3D percept depends on which correspondence is assumed.

(a) An external object generates a left retinal image and a right retinal image. The correspondence problem is the problem of deciding which features in the left retinal image correspond to (i.e., were generated by the same external object as) which features in the right retinal image.



(b) If we assume that A corresponds to C and B corresponds to D, then we perceive two dots, side by side. If we assume that A corresponds to D and B corresponds to C, then we perceive two dots, one behind the other.

(In fact, with a stimulus like this we perceive two dots side by side, even when there are actually two dots, one behind the other. This is called the *two nail illusion*.)

2. An insurance company consults you about a man who says he has been made almost deaf by noise in the workplace. You test the man in an auditory detection task, where he tries to detect a tone that is moderately detectable by people with normal hearing. You obtain the following response matrix.

	responds "yes"	responds "no"
auditory signal present	0.10	0.90
auditory signal absent	0.55	0.45

(a) Is the man almost deaf? (b) What is unusual about the man's response matrix? Explain your answers.

(a) The man is not almost deaf. He responds very differently depending on whether the sound is present or absent, e.g., he responds "no" much more often when the sound is present than when it is absent. So he is clearly able to respond to the sound.

(b) What is unusual is that he is more likely to respond "no" when the sound is present, and "yes" when the sound is absent. The man is probably pretending to be deaf. When he hears the sound he usually responds "no", and when he does not hear the sound he splits his answers about equally between "yes" and "no".

3. The auditory system contains a large number of frequency channels, e.g., auditory nerve fibers that only respond to a limited range of frequencies. Suppose you listen to a pure tone (i.e., an auditory sine wave) for a long time. How will this affect the pitch of other pure tones, slightly higher or lower in frequency, that you listen to immediately afterwards? (Hint: think of an analogy with motion aftereffects, and how they can be explained in terms of motion channels.)

If auditory frequency channels can be fatigued, then adapting to a pure tone should produce a pitch aftereffect much like a motion aftereffect. Suppose we adapt to a pure 900 Hz tone, fatiguing the 900 Hz channel, and then listen to a 1000 Hz tone. As we listen to the 1000 Hz tone, the 900 Hz channel will respond less than usual, whereas the 1000 Hz and 1100 Hz channels will respond normally. This is the pattern of activation normally generated by a tone slightly above 1000 Hz, so we will experience a pitch aftereffect: the 1000 Hz tone will sound like it has a frequency slightly higher than 1000 Hz.

D. Bonus vocabulary questions

Define the following words. Each question is worth one bonus mark.

1. undulate

move with a smooth and wavelike motion

2. salient

noticeable, conspicuous, attention-grabbing