

unable to deal with certain results {55}, or that the conceptual foundations of such theories are incoherent. Pylyshyn, in particular, has been vigorously pursuing all these strategies since 1973 {56}. As was seen in the previous chapter, I do believe that in the end **quasi-pictorial** theories of imagery fail on empirical grounds. However, I also believe that 'descriptive' theories of imagery fail even more drastically to convincingly deal with the empirical evidence, and I believe that the whole notion of 'propositional' mental representation ultimately fails to make sense.

§II.C.4. Imagery and Perceptual Processes.

It is characteristic of descriptive theories of imagery that they deny that having an image involves any specifically **perceptual** processes. Thus, if unequivocal evidence were available that imagery does involve such processes then descriptionism would be effectively refuted. There is, in fact, a good deal of evidence to this end, although we shall see that it is not beyond challenge. For a start, the sort of 'selective interference' experiments done by Perky {1} and Segal {2}, in which visual mental imagery seemed to interfere with the perception of a faint visual stimulus (or at least with its perception as visual rather than imaginary) {3} do seem to suggest that imagery processes may be making use of some of the mechanisms

normally required by perception, and thus interfering with it. Especially suggestive in this regard is the fact that the interference seems to be largely specific to the sensory mode in which the image presents itself (4). The 'selective interference' effects demonstrated in the work of Brooks, Atwood, Janssen, Baddeley and others (5) show the converse effect, of perceptual tasks interfering with imagery, and, despite the interpretive complexities discussed earlier, tend towards the same conclusion. However, even Kosslyn & Pomerantz (6) admit that 'propositional' theories can account for effects of this type without too much strain. The descriptive 'propositions' (or 'mental sentences') underlying imagery, it may be suggested, will be similar in their type of subject matter to those produced by perception, and thus confusion, leading to poorer performance, may well result. Although this suggestion may remain somewhat *ad hoc*, it does not seem as artificial as do those called for by 'propositional' accounts of the mnemonic, rotation and size effects of imagery.

More recently, however, a number of experiments seem to have demonstrated the sharing of mechanisms by imagery and perception in ways that are less easily assimilated to 'descriptionism'. Broadly speaking, these all involve the production of various perceptual 'illusions' by means of imagery rather than by the real perceptual inputs which are known to produce them. The most important researcher in this area has been Ronald Finke

{7*}, one of whose studies is concerned with the effects of imagery on the movement adaptations of people wearing prism goggles {8*}. Such goggles deviate a person's line of sight away from straight ahead, and initially, when someone wearing them tries to reach for or point at an object their hand will in fact go considerably to one side of it. However, there is a gradual, but quite rapid, adaptation, and before very long the wearer will be able to point and reach quite accurately. This adaptation is **not** a matter of conscious compensation for the error, and when the goggles are removed a negative aftereffect appears; the subject will, at first, miss pointing at things in the opposite direction to that in which he missed them upon first wearing the goggles. Furthermore, even when the pointing is only done with one hand, under some circumstances a certain amount (but not all) of the adaptation and aftereffect will transfer to the other hand. Finke's experiments show that similar patterns of adaptation, aftereffect and inter-manual transfer can occur when the pointing errors are not seen by the subject, but only imagined {9}.

The details of Finke's ingenious series of experiments on prism adaptation are far too complicated to explain here, but the basic experimental set-up involved the subject wearing the prism goggles and sitting at a table, across which was the target object for them to point at. They could not see their pointing arm because the pointing took place underneath the table top. However, they were instructed to imagine that each time they tried to

point at the target they saw their hand in fact arrive at a marker to one side of the target. The experimenter placed this so as to mark the positions where the hand would have arrived, at the relevant stage of adaptation, if it could in fact be seen. Finke also carried out variations of this procedure in which he placed the marker so as to systematically mislead the subjects as to where their hands would be arriving, so that the arm movements imagined were not the same as those actually made. Sometimes, also, actual movements were not made at all, although the subject was still asked to imagine that he saw his hand arriving at the relevant error marker. As I said, the details of these experiments are very complicated, but the results are fairly clear. The patterns of adaptation, aftereffect and inter-manual transfer produced by the imaged movements were entirely similar to those known to obtain when pointing movements can actually be seen. The effects produced by imagery were systematically smaller than those produced by genuine visual feedback, but it is notable that subjects capable of more vivid imagery (as measured by the Marks "VVIQ" self-report questionnaire {10}) showed larger effects than did the less vivid imagers.

Pylyshyn {11}, as we have seen, attempts to explain away many imagery effects as simply a matter of the subject using the "tacit knowledge" {12*} which he has acquired in the course of his everyday perceptual experience. Such knowledge, Pylyshyn claims, enables the subject to deliberately reproduce the results which he would produce

in the relevant perceptual situation, and he will take this to be just what the imagery instructions to be demanding of him. But the details of prism adaptation and its aftereffects, and particularly of the inter-manual transfer effects, are rather esoteric, and certainly not part of everyday perceptual experience, so it does not seem as though Finke's results can reasonably be explained in this way. What is more, at least some aspects of these effects seem to be 'cognitively impenetrable' in just the sort of sense in which Pylyshyn has argued that imagery is not {13}. Someone wearing prism goggles can see that he is missing the target, and by how much, straight away. But this conscious awareness seems to be only partly responsible for the adaptation, which takes place fairly gradually. If adaptation were a matter of deliberate, rational adjustment then surely we would not expect to find aftereffects when the goggles are taken off, and inter-manual transfer ought to be total, and not partial as it is.

An even more esoteric visual 'illusion' whose imagery equivalent has been studied by Finke, and with even more striking results, is the so called McCollough effect. This effect {14} is produced when subjects look for some time at a pattern of black bars on a coloured background. After someone has looked at such a pattern for some time (about five minutes is normally sufficient) they find that if they look at a similar black bar pattern on a white background then the white areas between the bars appear to

be faintly tinged with the colour complementary to that in the original pattern. This is not at all the same as the well known negative afterimage which arises from the fatigue of retinal receptor cells. The McCollough effect does not require fixed staring at a single point on the inducing pattern, it does not 'float' before the eyes like an afterimage, the colour only appears on the relevant bar pattern, and unlike an afterimage, which fades quickly, a McCollough effect may persist for hours, days, or even weeks. What is more, it is possible to experience more than one McCollough effect at a time. If an inducing pattern is used which contains areas of horizontal bars on a background of one colour and of vertical bars on another colour then horizontal bars on white will subsequently be tinged with one complementary colour, and vertical bars on white with the other. A pattern with areas both of vertical and of horizontal bars will show both the appropriate complementary colours in the appropriate areas. To the best of my knowledge, the mechanisms of this effect remain pretty mysterious {15*}, //but certainly//they are to do with specifically visual processes and not 'central', 'cognitive' ones.

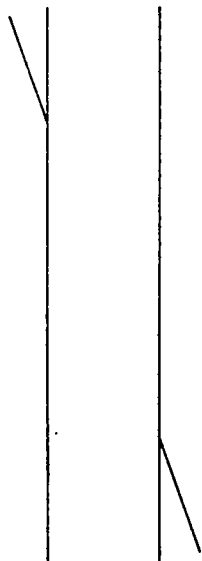
In the initial study by Finke & Schmidt {16} it was attempted to induce a McCollough effect through imagery. They tried two methods: either presenting the subjects with colour fields (green or red) and asking them to imagine patterns of vertical or horizontal black bars on them; or else presenting patterns of black bars on white, and asking

the subjects to imagine the white background as coloured. The subjects were then tested by being shown a black and white bar pattern with vertical bars on one side and horizontal on the other. They were asked to indicate which side of this pattern seemed most red or, if no red tinge could be detected, which side was least green (no "don't know" responses were allowed) {17}. On post-experimental questioning Finke & Schmidt {18} found that about half the subjects, perhaps because they did not see colour at all on the test patterns, had treated the experiment as a memory test and had reported the previously seen or imagined colour as going with the bar pattern with which it had been previously been paired. These subjects were excluded from the main analysis. The remainder of the subjects did claim to have responded according to faint colours which they actually saw. For these subjects, when they had imagined bars on a (truly) coloured background most of them reported seeing the complementary colour in the relevant part of the test pattern, just as in the regular McCollough effect. This was the hoped for result, and seems to show that imagery must make use of the same relatively peripheral visual mechanisms (whatever they are) which are involved in the regular McCollough effect. The results for the cases where the subjects had seen real bars and had imagined the coloured background were in the opposite direction. Where colours were seen on the test stimuli they were usually the same as those which had been previously imagined. This result seems to have been unexpected. However, it is not disastrous, for such a 'reverse McCollough effect' is not

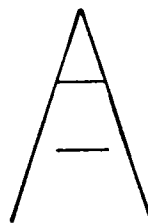
unknown in studies using entirely perceptual stimuli. McKay & McKay (19) used an apparatus which allowed them to simultaneously present a coloured field to one eye, and a pattern of bars to the other, and these stimuli, presented together, were used as the adaptation pattern. When the relevant achromatic bar pattern was subsequently presented to the eye which had been exposed to the colour a weak McCollough effect was produced (i.e. the complementary colour was seen). However, when the bars were shown to the eye which had previously been exposed to bars, a weak 'reverse McCollough effect' occurred (i.e. the area between the bars seemed tinged with the colour which the other eye had actually been exposed to), as it had when the Finke & Schmidt subjects had been exposed to bars and had imagined colours. Finke argues that the different results produced by the bar imagining and the colour imagining conditions show

that while mental images and physical objects can be functionally equivalent at levels of the visual system where pattern information is processed, such equivalences do not extend to levels where color information is processed. (20*)

Be that as it may, the fact that any aftereffects at all were produced by merely imagined stimuli is very striking. Furthermore, in a subsequent study Finke & Schmidt (21) applied their bar imagination condition to subjects who had assessed the vividness of their own visual imagery by filling out the Marks VVIQ questionnaire (22). It was found that imagery induced McCollough effects were experienced far more often by the more vivid imagers. This would seem to provide further reason to believe that the observed



Poggendorff illusion.



Ponzo figure

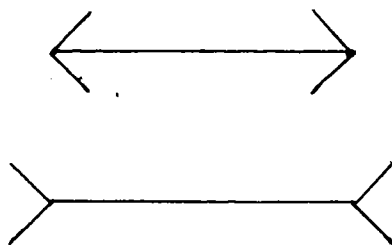
(Reproduced from Wallace [1984].)

(Reproduced from Pressey & Wilson [1974].)



Wundt figure and Hering figure

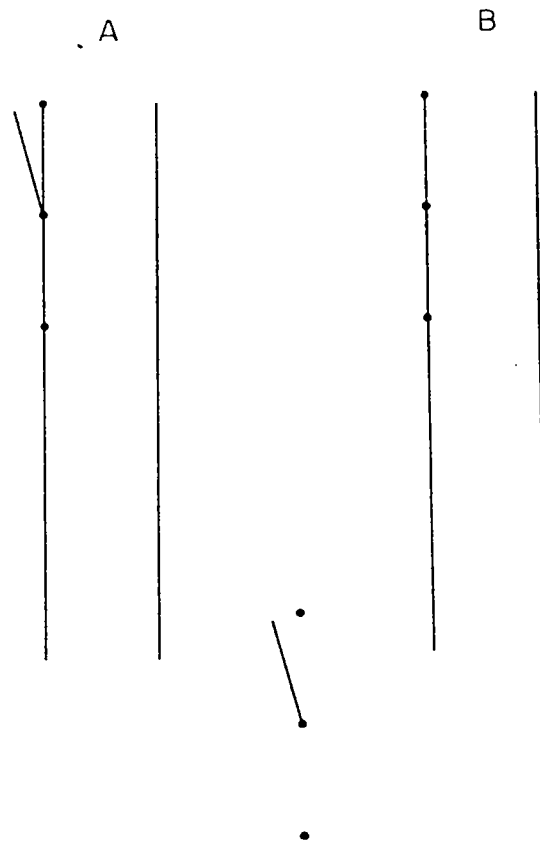
(Reproduced from Wallace [1984].)



Müller-Lyer Illusion

effects really are due to imagery.

These studies by Finke are of rather exotic effects, but other workers have succeeded in inducing some of the well known geometric 'optical illusions' through imagery. The illusions in question are the Poggendorff, the Müller-Lyer, the Ponzo, the Wundt and the Hering illusions, whose standard forms are shown in figure II.C.4_1. Illusions like these are relevant because, like the effects studied by Finke, they seem to involve processes which are not what Pylyshyn (23) calls "cognitively penetrable". That is to say that however well we know that they are illusions, the perceptual effect still persists (24*). Pylyshyn himself argues that "cognitively impenetrable" processes should not be taken as aspects of the central computational processes of the mind. They are like the bio-computer's "hard wired" peripherals - input and output devices - rather than its fully programmable central processor (25). Pylyshyn's argument (well, one of them) against specific image representation mechanisms is that imagery is cognitively penetrable (a point which we have accepted in §II.B.5 above). Therefore it must be produced by the central processes, where all types of information are brought together, and which, as the computer metaphor demands, works entirely with language-like 'propositional' representations. Accepting for the moment the 'information processing' paradigm, the experiments being discussed in this section (above and below) seem to show that imagery can serve as an input - seemingly equivalent to perceptual



Poggendorff targets employed in the experiment.

Figure II.C.4_2
 (Reproduced from Pressey & Wilson [1974].)

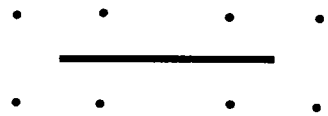


Figure II.C.4_3
 (Reproduced from Berbaum & Chung [1981].)

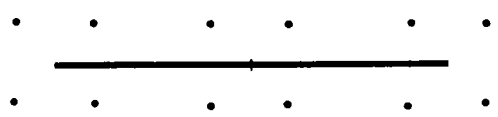


Figure II.C.4_4
 (Reproduced from Berbaum & Chung [1981].)

inputs - into cognitively impenetrable, fairly peripheral mechanisms. Imagery must then, presumably, arise at a more peripheral stage than these mechanisms, and cannot be an aspect of central, fully computational processes (26*). If this is right then Pylyshyn's descriptionism is refuted. We, of course, can escape from the dilemma seemingly produced by imagery having both 'cognitively penetrable' and 'cognitively impenetrable' aspects by abandoning the sequential, 'information processing' model of perception. But that is to get ahead of ourselves. For now we must look further at the evidence that 'cognitively impenetrable' perceptual illusions can be produced through imagery.

The earliest demonstration of a geometric illusion produced by imaginal processes seems to have been the experiment of Pressey & Wilson (27), who demonstrated a version of the Poggendorff illusion with stimuli as shown in figure II.C.4_2a,b. (In fact three versions of each of these figures were used, with different angles between the oblique and vertical lines.) The first of these figures, where the oblique meets one of the parallels, was used in the control condition. The subjects were asked to indicate where the oblique line, if produced, would meet the right hand vertical. In the standard Poggendorff figure (see figure II.C.4_1) the actually co-linear right hand oblique segment appears as too far down, and consequently the control subjects indicated a higher point on the right hand vertical than was really correct. Even this version of the experiment would seem to involve imagery to some extent, as

the produced line segment has to be imagined. However, imagination plays an even larger part in the main experimental condition, in which the oblique line was given detached from the two parallels (figure II.C.4_2b) and the subjects were required to imagine it in place on the left hand vertical (so that the three dots in each part of the figure coincided) before estimating where it would cut the right hand vertical if produced. The results in this condition were effectively the same as were found in the control condition, where the oblique line was actually in place on the left vertical. There was no evidence of a smaller effect in the 'imagined' condition (28). The constructed 'mental image' of the illusive figure seems to produce the illusion as effectively as does the complete figure itself.

For experiments of this sort to be reliably interpreted as showing genuine effects it is important that the subjects should not previously have known about the illusion in question. If they did know about it an explanation in terms of experimental demand characteristics would be very plausible. Pressey & Wilson had to reject the data from two of their subjects because they were found, in post-experimental interviews, to have had previous experience of the Poggendorff illusion. The Müller-Lyer figures are rather well known in the West, and so might be thought inappropriate for this kind of study. However, the subjects used by Berbaum & Chung for their demonstration of an imagery version of the Müller-Lyer were Korean

engineering students and their spouses, and the experimenters were confident that they were not familiar with the illusion {29}. These subjects were given the figure shown here as II.C.4_3, and asked to alternately imagine that there were 'arrowheads' on the horizontal line, formed by lines connecting its ends to the inner pair of dots, or that there were 'wings' formed by connecting the line's ends to the outer dots. The two versions of the Müller-Lyer figure were thus alternated in imagination. It was intimated to the subjects that some sort of illusory length change might occur as they did this - but they were not told the directions in which these changes might be expected. In the event, nineteen out of the twenty subjects who took part "spontaneously" reported length changes, and all in the expected directions {30}. (The twentieth subject reported no changes.) Berbaum & Chung also tried using the figure shown here as II.C.4_4 as the stimulus, which they hoped would enable the subjects to imagine two actually equal line segments (i.e. the two halves of the horizontal line) simultaneously, but one with 'arrowheads' and one with 'wings'. Several subjects found this feat of imagination to be beyond them. However, those who did manage it reported a "verry compelling difference" in apparent length between the two halves of the bisected horizontal line {31*}.

With these results in mind, and mindful also of the experiments and theoretical arguments of Finke, Wallace {32} set out to demonstrate the inducement of three more

standard illusions through imagery. The illusions he used were the Ponzo, the Wundt and the Hering (see figure II.C.4_1). The subjects which Wallace used had all previously filled out a VVIQ questionnaire (33) on their ability to form vivid visual imagery, and on this basis Wallace divided his subjects into 'high', 'middling' and 'low' imagers. Each group of subjects used in the experiments on the illusions consisted of half 'high' imagers and half 'low' imagers. The control groups were shown the usual illusion inducing figures. All of these subjects experienced the illusions, and provided estimates of their extent in millimetres. The other subjects were first shown only the 'inducing' parts of the illusory figures (which, as it happens, are the oblique lines, in each case). These were then removed and the subjects were presented with the other parts of each illusion (which in each case here are pairs of equal, parallel, horizontal, straight lines. They were then asked to imagine the figure which they had just seen (i.e. the relevant inducing, oblique lines) superimposed in the appropriate way on the two lines before them, thus producing the standard illusory figures partly as imagery and partly as physical stimulus. In only one case did any of the 'low' imagers (when trying for the Ponzo figure) say that they were able to do this, but all of the high imagers said they could, and all of them reported that the illusion was produced. Their estimates of the size of the effect were only non-significantly lower than the estimates provided by the subjects shown the normal, complete figures (34).

