Property Transmission: An Explanatory Account of the Role of Similarity Information in Causal Inference

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Many kinds of common and easily observed causal relations exhibit property transmission, which is a tendency for the causal object to impose its own properties on the effect object. It is proposed that property transmission becomes a general and readily available hypothesis used to make interpretations and judgments about causal questions under conditions of uncertainty, in which property transmission functions as a heuristic. The property transmission hypothesis explains why and when similarity information is used in causal inference. It can account for magical contagion beliefs, some cases of illusory correlation, the correspondence bias, overestimation of cross-situational consistency in behavior, nonregressive tendencies in prediction, the belief that acts of will are causes of behavior, and a range of other phenomena. People learn that property transmission is often moderated by other factors, but under conditions of uncertainty in which the operation of relevant other factors is unknown, it tends to exhibit a pervasive influence on thinking about causality.

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What goes on in a causal relation? More specifically, what do causes do to their effect objects? When a moving billiard ball contacts a stationary one, why does the moving one make the stationary one move, rather than deforming it or changing its color? What understanding do people have of this phenomenon, and how does it affect the judgments they make about causality? This kind of question has received relatively little attention in psychology. Research on causal judgment has been dominated by the Humean tradition in which causes are identified by extrinsic cues, such as empirical association with effects (e.g., Allan, 1993; Cheng, 1997; Shanks, 1995), and has therefore tended to focus on the issue of how causes are identified from available empirical information. There has been little attempt to look inside the causal relation to see what is going on there. If people have an understanding of causation in which causes actually produce or generate their effects (Shultz, 1982; White, 1993), this raises a different set of questions concerning people’s understanding of the generative relation, focusing more on the content of causal relations than on extrinsic indicators of their occurrence.

Consider some examples. In one, someone grasps and lifts an object. Part of what is involved in that causal relation is that the kinematic properties of the actor’s hand are imposed on the object. The object is displaced in a way that is determined by and corresponds to the motion of the hand when the two are in contact. In another example, the back of a spoon is pressed into a pile of mashed potatoes, producing a spoon-shaped indentation in the potatoes. In this case, a different property of the causal object, its shape, is imposed on the effect object. The shape of the mashed potatoes is determined by and corresponds to the shape of the spoon. Why is this? Why does the spoon cause a spoon-shaped indentation, instead of setting the potatoes on fire or turning them green? Without probing too deeply into the physical details of the interaction, it is possible to say that the cause object imposes some of its own properties on the effect object. The spoon-shaped indentation occurs because the causal object has that shape and imposes it on the effect object. In both examples, then, the causal object imposes some of its own properties on the effect object, and this feature of the causal relation is readily observable. However, people may perceive or infer causality in these cases, no observer would be in any doubt that the actor’s hand brought about the kinematic properties of the object being lifted or that the shape of the spoon determined the shape of the indentation in the potatoes. A fingerprint preserves the properties of the finger that made it, and a detective who identifies the owner of the finger will have little interest in assessing contingency.

It is also possible to find examples in which this imposition of the causal object’s properties does not occur. When a stone smashes a pane of glass, the outcome for the glass is determined as much by its properties as by those of the stone. A similar stone traveling at similar speed will produce different outcomes depending on the properties of the objects it contacts. Even so, there is a tendency for the kinematic properties of the stone to impose themselves on the effect object. Greater speed of contact, other things being equal, produces greater speed of motion of the shattered fragments of glass. In other cases, some kind of interaction takes place between the properties of cause object and effect object, resulting in an outcome that does not obviously resemble either. A virus produces symptoms, let us say, of fever and nausea, which do not obviously resemble any pre-existing property of either virus or victim. Pressing Control–V on a computer keyboard results in a copied section of text appearing on a computer screen, an outcome that does not obviously resemble its cause. So cases in which properties of the cause object are imposed on the effect object, while they may be...
commonplace, are far from universal, and it is not easy to say in
general terms which sorts of causal relations exhibit this feature
and which do not.

I propose that the idea that causes tend to impose their own
properties on effect objects operates as a general theory about
causal relations and that it is used to guide judgments about
causality made under conditions of uncertainty, in which it func-
tions as a heuristic for prediction, for causal identification, and for
interpretation of uncertain events. There may be uncertainty about
whether any causal relation has occurred at all, or the cause may
be known but its effect is uncertain, or the effect may be known but
its cause is not known. Under any of these circumstances, the idea
of causes tending to impose their own properties onto their effects
may be used as a guide to reducing uncertainty, as long as
preconceived beliefs do not exclude this possibility. I shall call this
general theory the property transmission hypothesis. The property
transmission hypothesis is acquired from experience of many cases
in which property transmission is veridical, but because the con-
ditions under which property transmission occurs are hard to
specify, the hypothesis tends to be applied beyond its proper
bounds, resulting in bias and error in various forms of causal
judgment and belief.

The earliest developmental evidence of perception guided by
the property transmission hypothesis comes from research by Kotovsky
and Baillargeon (1998). In this study, stimuli were presented in
which a cylindrical object rolled down a ramp and contacted a
model bug on wheels, which then rolled off a certain distance.
Infants between 5.5 and 6.5 months old were habituated to this
demonstration. They were then shown either a large or a small
cylinder rolling down the ramp, and in both cases the bug rolled
further than it had done in the habituation trials. Infants looked
longer at the stimulus involving the small cylinder than at the
one involving the large cylinder, indicating that they found the
stimulus involving the small cylinder surprising. This finding
shows an early expectation that bigger objects produce bigger
effects, which can be interpreted as a case of property trans-
mission in which the size of the causal object determines the
size of the effect produced.

An enlightening perspective on this finding is provided by
Wang, Kaufman, and Baillargeon (2003). These authors reported
evidence that the size of the effect object is not taken into account
in causal perception until infants are about 9 months of age. Before
that time, infants respond as if they expect all effect objects to be
displaced by a given causal object, regardless of the apparent size
of the effect object. To the extent that object size indicates mass,
the outcome for the effect object is objectively affected by the size
of both the causal object and the effect object, other things being
equal; yet an appreciation of the former kind of influence develops
prior to an appreciation of the latter kind. It is not clear whether
this difference generalizes to other contexts, but if it does, it
suggests that an appreciation of the role that causal objects play in
determining outcomes, specifically via property transmission, is
acquired earlier than an appreciation of the role that effect objects
play and that it is perhaps more natural for humans to think in
terms of causal objects transmitting their properties to effect ob-
jects.

As a general theory, big causes big is not bad, but it is not
always accurate. Balloons are bigger than tennis balls but tend to
produce smaller displacements of objects with which they collide,
other things being equal. Thus, learning about causality involves,
among other things, learning more sophisticated and accurate
versions of property transmission: it is the (unobservable) mass,
rather than the (observable) size, of the object that determines the
outcome. Learning about causality also involves learning about
circumstances under which causality does not involve property
transmission. To the extent that such learning comes after learning
about property transmission and qualifies it rather than disconfirm-
ing it, I would argue that the influence of the property transmission
hypothesis continues to be felt, under conditions of uncertainty,
under conditions of high cognitive load, and in cases in which
reasoning is implicit rather than explicit. Later in this article, I
shall develop this claim by showing how the property transmission
hypothesis may contribute to an understanding of several judg-
mental tendencies.

Grounding of the Property Transmission Hypothesis:

Examples of Veridical Property Transmission in
Causal Relations

Property transmission is a veridical characteristic of some fa-
familiar kinds of physical causality, and I shall briefly consider some
eamples.

Michotte (1963) argued that there were two fundamental kinds
of perceptual causality: launching, which will be discussed later,
and entraining. In the typical stimulus for entraining, one object, B,
is initially visible and stationary in the center of the display. A
second object, A, moves horizontally from left to right in a straight
line at constant speed. When it contacts Object B, both objects
move without pause at the same speed and in the same direction as
Object A had before contact, so that the two objects remain in
contact while motion continues. Observers reliably report a visual
impression that Object A pushes or carries Object B. Thus, al-
though both objects are in motion together, the motion is seen as
Object A’s motion, and Object B’s motion is seen as produced by
Object A’s acting on it. The type stimulus can be viewed as a
model for many kinds of events involving pushing or carrying,
such as pushing a wheelbarrow or picking up a book and moving
it to another place. In the case of entraining, property transmission
appears to be veridical. For the two objects to remain in contact,
they must have the same kinematic properties. Michotte did not
investigate the effect of relative speed or direction before and after
contact, and this does not appear to have been tested in any
subsequent research; in the typical stimulus, speed and direction
are the same before and after contact. However, it can at least be
said that the kinematic properties of Object B during the entraining
phase of the stimulus are (seen as) determined by Object A, the
causal object: Object A transmits its own kinematic properties to
Object B for the duration of the entraining event.

Property transmission occurs in interactions between relatively
rigid objects and relatively deformable ones. There has been little
research on how interactions of this kind are perceived. However,
numerous examples could be given. In addition to the example
involving the spoon and the mashed potatoes already discussed, a
finger pressed into modeling clay creates a finger-shaped inden-
tation in the clay, and a shoe creates a print in soil. In these cases,
property transmission is obvious because the effect object retains
the indentation after the causal object is removed. In other cases,
such as squeezing a balloon or a teddy bear, the indentation tends
to disappear after the causal object is removed; nevertheless, the actor could have a haptic impression of property transmission, even if the visual impression is obscured.

Property transmission is characteristic of various kinds of marking and staining events. Paint or dye spilled onto fabric or applied to paper with a brush are examples. In the latter case, causally relevant features of the brush may be transmitted as well as the paint. When a pen or pencil is used to mark paper, the color of the mark on the paper is determined by the color of the ink in the pen. Among many other examples that could be given, heat makes things hot; ice makes things cold; water makes things wet; artificial lights illuminate things. Property transmission occurs in interactions in which it is perhaps less salient. The transfer of kinematic properties from stone to glass fragments when a stone smashes a window has already been discussed. Although the outcome is in part determined by causally relevant properties of the effect object, it also exhibits property transmission in some respects.

Property transmission occurs in the biological domain. In reproduction, cats produce cats, not elm trees. In cases in which the father of a litter of kittens or puppies is unknown, comparison between observable features of the offspring and those of various male cats or dogs in the neighborhood may be used for purposes of identification, under the assumption that characteristics of the father tend to be transmitted to offspring. However, biology is a domain that also illustrates most clearly that similarity does not necessarily indicate property transmission. Two oak trees may resemble each other not because one caused the other but because both share a common biological inheritance, even though their recent ancestral lines are distinct. I shall return to the issue of distinguishing between similarities that indicate property transmission and those that do not in the next section.

Mill (1873/1974) argued that effects often do resemble causes. Among the examples he gave are some from the domain of psychology: “[T]he thoughts, or reminiscences, which are effects of our past sensations, resemble those sensations; feelings produce similar feelings by way of sympathy; acts produce similar acts by involuntary or voluntary imitation” (p. 766). In general, actions and their intended outcomes tend to resemble the content of causally relevant antecedent mental states. An action of grasping an apple resembles the content of an intention to grasp an apple and that of a desire for an apple, both of which lie somewhere among the causal antecedents to the action. Children understand this from an early age (Woolley, Browne, & Boerger, 2006).

One kind of property that can be transmitted is the causal power of the causal object. Thus, when Billiard Ball A contacts Ball B and sets it in motion, Ball B acquires the capacity to set Ball C in motion. This could be regarded as a paradigm case of a chain of causal relations involving successive instances of property transmission, and in particular, a chain in which the capacity to produce a given effect is itself transmitted from one object to the next. A person who catches a disease such as influenza also catches the property transmission hypothesis from manifold experiences of causal relations in which property transmission is veridical and can be perceived as such. They learn that property transmission does not hold for all causal relations, for example, that the size of causal object is not always a reliable predictor of the size of outcome (Wang et al., 2003). In familiar domains or in cases in which adequate information for causal judgment is available, judgments about property transmission are therefore likely to be made in appropriate ways. However, in domains and situations characterized by uncertainty, because of unfamiliarity, unavailability of other cues to causal judgment, or difficulty in using available cues, the property transmission hypothesis then tends to function as a heuristic for prediction of outcomes, identification of causes, or judgment of empirical relation between causes and effects that do or do not resemble each other. When this happens, use of the property transmission hypothesis may result in error and bias in judgment.

Criteria for Identification of Property Transmission and Its Use in Causal Inference

Many instances of resemblance occur because two things share the same generative process, not because one of them caused the other. Two oak trees side by side in a field resemble each other because both of them were generated from acorns that shared similar genetic material. Two chairs resemble each other because both were constructed by the same manufacturing process. Perceived resemblances may also be coincidental and imply nothing about common generative processes. A vegetable may have features that resemble those of a human face, but vegetables and faces are generated by different mechanisms. How do we decide which instances of resemblance can be explained as coincidence or by common generative processes and which can be explained as causal relations involving property transmission? I propose three main cues to the identification of property transmission. These can be illustrated by the examples of the spoon being pressed into mashed potatoes and the two chairs that resemble each other because of a common manufacturing process.

First, some kind of activity should be either perceived or described as occurring. Activity is critical to the identification of interactions as causal relations. When a plate is resting on a table, this is an interaction in terms of the laws of physics because both objects are exerting forces on each other. However, people do not see or judge forces as being involved in such cases, unless they have had appropriate physics education, because no activity seems to be going on (Clement, 1987; diSessa, 1993; Gutierrez & Ogborn, 1992; White, 2006). Activity is perceived when the spoon is being pressed into the potatoes, but not when the two chairs are just sitting side by side.

Second, cues to generative transmission indicate that, over and above mere activity, an interaction is also taking place between the two objects that should be perceived or described as present. There is evidence that generative transmission cues are fundamental to causal inference, and preferred to other cues such as contingency, from an early age (Shultz, 1982; Shultz, Fisher, Pratt, & Rulf, 1986). In the systems exploited in that research, the cues involved transmission across a gap between cause and effect objects, such as transmission from a bellows to a candle flame. However, there is also evidence that interactions such as that between the spoon and
the mashed potatoes are perceived in terms of generative transmission, specifically involving the exertion of force by the spoon (or its user) on the potatoes (White, 2007, in press). Generative transmission by the exertion of force therefore distinguishes the spoon being pressed into the mashed potatoes from the two chairs. Even if one of the chairs is active, for example, if it is on wheels and rolls past the other chair, the mere occurrence of this activity is not sufficient for an inference of property transmission unless there is also evidence that one chair is exerting force on the other.

Third, the interaction should be characterized by a salient time-ordered resemblance between the properties of cause object and effect object. Specifically, there should be a resemblance between some property of the cause prior to the interaction and some novel property of the effect object present after the interaction. In the case of the spoon and the potatoes, the pile of mashed potatoes does not have a spoon-shaped indentation before the occurrence of the interaction, but it does have one afterwards. Thus, even if the chair on wheels rolls into the other chair, so that some kind of interaction takes place between them, this would still not be interpreted as an instance of property transmission because the properties that the effect object shares with the cause object were possessed by it before the interaction occurred. If the wheeled chair damaged the other chair, for example, if some paint on the wheeled chair adhered to the other chair, leaving a visible mark, then this would be interpreted as a case of property transmission but specifically relating to the property that the causal object possessed prior to the interaction and the effect object possessed only after the interaction.

The time-ordered resemblance criterion explains why some properties of the cause object are perceived as being transmitted to the effect object and not others. The spoon, for example, has numerous properties, including the shape of the bowl, the handle, its rigidity, and its shiny metallic surface. However, only the shape of the bowl is perceived as transmitted to the potatoes because that is the only property of the spoon that meets the time-ordered resemblance criterion. After the interaction has taken place—and not before—the pile of mashed potatoes has an indentation that matches the shape and size of the bowl of the spoon, but it does not have rigidity or a shiny metallic surface.

These criteria serve to distinguish instances of (perceived or judged) property transmission from instances in which resemblance is interpreted as being due to a common generative process or due to a coincidence. They also imply that property transmission will not be perceived or judged to be going on when things that are identified as interactions do not exhibit the time-ordered resemblance relation just described. This is exemplified by the system in which a bellows extinguishes a candle flame. Children as young as 2 years old identify this action as a causal relation by means of generative transmission cues (Shultz, 1982), but it is not seen as involving property transmission because there is no apparent time-ordered resemblance between properties of the causal object and those of the effect object. The combination of all three criteria is necessary for the perception or inference of property transmission.

Because property transmission is a characteristic of many interactions in different domains, it tends to be adopted as a general hypothesis about causal interactions, which means that it will tend to be applied in interpretation of causal relations except in cases in which there are indications that it is not applicable. This extension in application of the property transmission hypothesis tends to be supported by acquired and often domain-specific causal knowledge. Take the example of handwriting characteristics, discussed later in the section on illusory correlation. The cause of a handwriting characteristic is unobservable because it is internal to the writer. However, handwriting is known from experience to be an activity, and moreover an interaction between writer and writing materials, and the handwriting produced evidently has features that were not previously present on the sheet of paper. Thus, people given only the domain-specific belief that handwriting features are influenced by personal characteristics of the writer may find this belief in the property transmission hypothesis sufficient to yield an inference about the relevant properties of the cause. In the case of magical contagion (also discussed later), a possible cause (e.g., a hated person) and an interaction (the hated person wearing a particular sweater) are known, but there is no evidence about the outcome. In this case, domain-specific beliefs about direct contact as a medium for generative transmission may be sufficient to infer that property transmission has occurred and that the sweater has acquired some characteristics of the wearer. The property transmission therefore functions to make causal inferences by filling gaps in knowledge, gaps that concern the nature of a cause, the nature of an effect, or the occurrence of influence of one on the other.

Limits on the applicability of the property transmission hypothesis may also be learned. The apparent lack of time-ordered resemblance between properties of the cause object and those of the effect object is one obvious circumstance under which property transmission would not be inferred. Another would be the availability of a causal belief acquired in some other way that disconfirms the hypothesis of property transmission for the system in question. Apart from direct education, there are perhaps two main other ways of acquiring relevant causal beliefs, each of which will be briefly discussed.

One way is by the acquisition and utilization of domain-specific causal beliefs that disconfirm the hypothesis of property transmission for the case in question. There is evidence that causal judgment is preferentially guided by information about the operation of causal mechanisms and that people seek such information to make causal judgments (Ahn & Bailenson, 1996; Ahn & Kalish, 2000; Ahn, Kalish, Medin, & Gelman, 1995). Mechanisms have been defined as “a system of connected parts that operate or interact to make or force an outcome to occur” (Ahn & Kalish, 2000, p. 201) or “a system of parts that change as the result of interactions among them that transmit force, motion, and energy” (Thagard, 2000, p. 262). People also acquire numerous causal beliefs about particular domains, such as physics and biology, that constitute a loosely organized, incomplete, and sometimes inaccurate, but nonetheless useful, body of guidance for causal judgments (Atran, 1995; McCloskey, 1983; Rozenblit & Keil, 2002). Thus, a case of resemblance between properties of a candidate cause and those of an outcome might not be interpreted as a case of property transmission if acquired domain-specific beliefs about mechanisms indicate that there is no mechanism to connect the cause to the effect.

The other way is by the use of other cues to causal learning, such as contingency information. Contingency is a formal property of relations between causes and effects, and as such it is indifferent to the occurrence or nonoccurrence of similarity between the properties of causes and those of effects. This means that the use of
contingency information in causal learning can result in the acquisition of causal beliefs that are not characterized by property transmission. Indeed, the use of information about empirical associations could be the main way in which beliefs about causal relations are not characterized by resemblance between the properties of causes and their effects are acquired.

Beliefs acquired in either way would tend to override developmentally earlier tendencies in causal judgment, thereby attenuating the influence of early and general hypotheses such as property transmission. One would therefore predict that property transmission is likely to characterize the causal judgments of novices more than those of experts and of children more than those of adults. Even so, there may be a tendency for the influence of property transmission to persist in the judgments of adults and experts under some circumstances, such as conditions of high cognitive load or conditions in which judgments are influenced by implicit rather than explicit knowledge. Experts in Newtonian theory produce judgments about object motion that are influenced by the same discredited impetus theory that seems to influence judgments of nonexperts, as if a theory that their explicit knowledge tells them is wrong still lurks in their heads, influencing behavior when explicit knowledge does not come into play (Kozhevnikov & Hegarty, 2001). The same could be the case for the property transmission hypothesis.

The main claim in this article is that because property transmission is encountered in many different kinds of causal systems, it tends to become a domain-general hypothesis about causal systems. As such, it functions as a guide to causal inference under conditions of uncertainty. When the outcome of an interaction or some features of it are unknown, the property transmission hypothesis tells people what those features might be. When features of the outcome are known but the cause is not, the property transmission hypothesis tells people which candidate among a set of candidates may be the cause. When an interaction appears to have taken place and the three criteria for interpretation in terms of property transmission are met, this may be taken as a guide to inference of a novel causal mechanism. (An example from the domain of alleged paranormal phenomena will be discussed later in the article.)

The corollary is that causal inference may be inhibited in cases of causal systems that do not exhibit property transmission. As an example, there is nothing about the symptoms of yellow fever that resembles either the virus that causes the disease or the mosquito that transmits it. If there are other cues such as generative transmission cues that indicate the occurrence of a causal relation between one thing and another, then the lack of time-ordered resemblance in properties may have no consequences for causal inference. However, in cases such as yellow fever, no such cues are available. In the absence of established propositions about causal mechanisms, the use of alternative cues to causality such as contingency may be rendered more difficult by the lack of resemblance between the observable properties of effects and their possible causes. I chose yellow fever as an example because Nisbett and Ross (1980) reported an anecdote in which a newspaper poured scorn on the hypothesis that a mosquito might be the cause of the disease. Nisbett and Ross argued that the newspaper dismissed the mosquito hypothesis precisely because the hypothesized cause did not resemble the properties of the effect in salient features. I propose that this is an example of a general tendency that makes it more difficult to identify causes in the absence of cues to property transmission and that candidate causes that do not fit the property transmission hypothesis are less likely to be accepted.

I now consider some cases in which judgmental tendencies appear to be influenced by the property transmission hypothesis. This is not intended to be a comprehensive review of the topics in question, merely an investigation of the extent to which the property transmission hypothesis could contribute to a full understanding of them. In most cases, the property transmission hypothesis is complementary to existing models and hypotheses, not disconfirmatory for them: It adds something of value that is not covered in existing treatments but that elucidates important features of the topics in question.

### Phenomenal Causality

The impression of entraining has already been discussed, and I have argued that in cases of pushing, lifting, and carrying, property transmission is a veridical feature of the causal relation. In this section, I focus on the other form of phenomenal causality regarded as fundamental by Michotte (1963), launching. The typical stimulus for launching is similar to that for entraining except that when Object A contacts Object B, Object A remains stationary at the point of contact. Observers consistently reported an impression that Object A caused the motion of Object B by bumping into it, an impression known in English as the *launching effect* (Michotte, 1963). Numerous subsequent experiments have confirmed that this causal impression is a product of perceptual processing consistently evoked by a stimulus with appropriate kinematic properties, even though there is no causality actually present in the stimulus (Gordon, Day, & Stecher, 1990; Natsoulas, 1961; Schlottmann, Ray, Mitchell, & Demetriou, 2006; Scholl & Tremoulet, 2000).

The likelihood of occurrence of the launching effect is maximized if the kinematic properties of Object B after contact are identical to those of Object A before contact. The strongest impressions of launching occur when both objects move at the same speed. The impression tends to be present but weaker if Object B moves more slowly than Object A, and it tends not to occur if Object B moves more quickly than Object A (Natsoulas, 1961). This is a curious finding, because the effect object moving with the same velocity as the causal object is not a typical outcome of a collision event.

Runeson (1983) pointed out that the combination of Object A stopping dead and Object B moving with the same speed as Object A is an unusual case. It can only happen if the causal object is not more massive than the effect object, and then it only happens when the ratio of the masses of the objects equals the coefficient of restitution. The coefficient of restitution represents the way in which the material qualities of the objects contribute to determining the outcome of the collision; for example, a sandbag has a low coefficient of restitution and a steel ball has a high one. Since there is no necessary connection between the mass ratio and the coefficient of restitution, the case in which they are equal is unusual and unrepresentative.

But there is more to it than that. In collision events, energy is conserved. One might suppose, therefore, that Object B initially should have the same velocity that Object A had at contact if they have the same mass. However, not all of the energy supplied to the
collision by Object A goes into making Object B move. Some of it is expended in deformation of both objects, and some is converted into other forms such as heat and sound. In addition, Object B usually slows down rapidly after the initial thrust from Object A because of such factors as friction and air resistance. Billiard ball collisions are unusual because the objects are unusually rigid and the surface of a billiard table is designed to minimize effects of friction. In a typical collision event, therefore, the speed of Object B after contact will be less than that of Object A prior to contact, often considerably less. The typical launching effect stimulus, the stimulus under which the launching effect is strongest or most reliably reported, far from being representative of natural collision events, is in fact anomalous.

The effect of direction is even more striking than that of speed. Michotte (1963) reported that the launching impression was very sensitive to direction of motion and tended not to occur if Object B’s direction differed from Object A’s by only 25°. This too is unrealistic. In collisions between billiard balls, for Object B to move in the same direction as Object A requires exact dead-center contact; any off-center contact results in Object B moving in a different direction. In general, the direction of B’s motion relative to A’s depends on the shapes of the objects and their deformation at contact, but the launching effect appears not to be attuned to these basic physical facts about collision events.

It cannot be said that a collision event in which the effect object moves more slowly than the causal object, or in a different direction, is any less a causal relation. If Object A makes Object B go when speed and direction are identical, it also makes Object B go when B moves at half the speed of A and at an angle of 40°. Causality is just as present in one event as in the other. Yet visual causal impressions do not reflect this simple fact. We have a causal impression in the former case but not in the latter. In the case of the launching effect, the strongest causal impression occurs when causally relevant properties of Object A, namely its kinematic properties, are transferred without alteration to Object B. This, I would argue, is an instance of the property transmission hypothesis: An interaction in which Object B moves at a different speed or in a different direction from Object A looks less like a causal relation because of the lack of property transmission.

Many of Michotte’s (1963) experiments illustrate the importance of property transmission to the occurrence of the launching effect. Perhaps the most striking example is the finding that physical contact between the two objects is not necessary for the launching effect to occur. If Object A stops short of Object B, the occurrence of the launching effect depends mainly on the speed of Object A prior to contact. The launching effect was more likely to be reported with larger gaps between the objects as the speed of Object A increased, a finding confirmed in a more systematic experiment by Yela (1952). This finding shows that property transmission is not the sole determinant of the causal impression, because increasing the size of the gap does make a difference. However, it is remarkable that the impression occurs at all under conditions in which there is no visible means of generative transmission from Object A to Object B. As Yela (1952, p. 152) commented, “Everybody knows perfectly well that it is not sufficient to stretch one’s arm in the direction of a ball to put it in motion, or to hammer in the air in order to drive a nail.” This can be interpreted as a case of a general tendency to apply the property transmission hypothesis beyond its proper bounds. In this case, the appearance of property transmission, combined with other relevant spatiotemporal cues, is sufficient to persuade the perceptual system that a causal relation is taking place.

Some authors have argued that the launching effect represents the operation of a visual perception module that is adapted to detect causal relations (Leslie & Keeble, 1987; Scholl & Tremoulet, 2000). If this were the case, the launching effect would occur under stimulus conditions that are more representative of actual collision events than is the stimulus that is actually optimal for the launching effect. But it does not. The values of kinematic variables under which the launching effect occurs match those that would be expected if perception was governed by the property transmission hypothesis and do not match those under which causal relations between real objects occur.

Perception can be adaptive and functional even if it is prone to inaccuracy. There is often a need for rapid identification of stimuli, for example, in the face of imminent threat from a predator, and there may therefore be adaptive value in having automatic but imperfect perceptual modules that produce rapid characterizations of stimuli to prompt swift action. It is likely that the adaptive value of such modules would be enhanced if they were overinclusive: It is more adaptive to recognize and evade anything that might be a predator, even if this adaptation means sometimes responding inappropriately to things that are not real threats, than to have a perceptual mechanism that fails to identify some things that are real threats. In this respect, the supposed module for the launching effect falls short of what would be desirable because it is highly specific, operating in response to only a minority of true causal relations. If we need rapid perceptual identification of causal relations at all, we need it for any kind of interaction between objects and not just for a subset that happens to conform to the property transmission hypothesis. Therefore, it is unlikely that considerations of adaptiveness play much of a role in determining the way the launching effect occurs.

The pulling impression provides a further example of property transmission at work. In a study by White and Milne (1997), five rectangles were initially presented arranged in a column with small but clearly visible gaps between them. As participants watched, the top rectangle began to move horizontally at constant speed; after a short delay, the second rectangle followed suit; and so on until all five rectangles were in motion. The objects never came into contact, never approached each other, and had no visible connection, and yet the stimulus gave rise to a vivid and compelling impression that the leading object is pulling the others. Subsequent, unpublished research (White & Pennington, 2003) revealed that similarity of both speed and direction of motion are critical to the occurrence of the pulling impression. If the objects move at perceptibly different speeds or in perceptibly different directions, the impression does not occur. This is a clear case of a visual causal impression that is dependent on property transmission; the causal object must be seen to transmit its motion properties on the effect object; otherwise, it is not seen as doing anything to the effect object.

In many real-life cases of pulling, this correspondence of speed and direction is observed and indeed is determined by the nature of the interaction: trucks pulling trailers and trains pulling carriages are obvious examples of veridical property transmission in pulling relations, but this is not always the case. The motion of kites and balloons does not always conform in either speed or direction to...
the motion of the hand that is pulling them, and if an object is fixed to a track, one can move away from the track and yet pull the object along the track if there is a long connection between actor and object. In this case, direction is not the same. It is therefore interesting that similar speed and direction are required for the pulling impression to occur, when they are not requirements in all cases of veridical pulling: Property transmission appears to play a role in the occurrence or nonoccurrence of the impression.

Magical Contagion

Magical contagion is one of the laws of sympathetic magic described by some early anthropologists, including Frazer (1890/1959) and Mauss (1902/1972). According to the principle of contagion, things that have been in contact can continue to influence each other through the transfer of some inner or nonphysical property such as an essence. More specifically, causal powers of an object or a person can be transmitted to an object with which the first object or person has been in contact. Contagion can be positive or negative: An object can acquire curative powers when touched by a healer and can acquire powers of harm-doing when touched by a sorcerer. Such cases of contagion exemplify property transmission: The causal relation involves the transmission of salient properties of the causal object to the effect object. In a reverse form of contagion, a doll or a model of a person is constructed and then harmed in some way, under the theory that the harm done to the doll transmits itself to the person whom the doll represents. The doll functions as a causal intermediary between the causal power of the sorcerer and the effect on the victim. The harm done to the doll is transmitted to the victim. Specific beliefs exemplifying contagion have been documented in numerous cultures, and they appear to represent a common, cross-cultural way of understanding causal mechanisms (Nemeroff & Rozin, 1994).

Nemeroff, Rozin, and colleagues carried out a series of studies showing that the behavior and judgments of Western (American) participants are influenced by thoughts of magical contagion (Nemeroff, 1995; Nemeroff & Rozin, 1989, 1994; Rozin, Millman, & Nemeroff, 1986; Rozin, Nemeroff, Wane, & Sherrod, 1989). Rozin et al. (1986) found evidence for some kinds of negative contagion, including a participant’s reluctance to consume a drink that had been briefly contacted by a dead but sterilized cockroach and a participant’s stated reluctance to wear a cleaned shirt of a style that the participant liked that had previously been worn by someone whom the participant did not like. Any belief in contagion, accurate or not, can be interpreted as an example of property transmission, in that causally relevant properties of one entity are believed to be transmitted to another entity, retaining the powers of their source. However, a belief in magical contagion represents an extension of the property transmission hypothesis beyond its proper bounds, where it acts as a guide to judgment and action under conditions of uncertainty.

In themselves, the findings just described do not prove that belief in magical contagion was at work; the participants might have believed that some potentially harmful or unpleasant substance could have remained in the drink despite the experimenter’s reassurances or on the shirt despite the fact that it had been cleaned. They only had the experimenter’s word that the cockroach was sterilized, and they might have believed that cleaning operations are not perfect. The critical study in this respect was carried out by Nemeroff & Rozin (1994). Participants were asked to rate how they would feel about wearing an attractive sweater that had had a number of different possible histories, such as having been worn by someone the participants thought of as the personification of evil. Nemeroff and Rozin found evidence for several different theories of contamination, each associated with different kinds of purificatory procedures. These included culturally accepted mechanisms such as germs or other physical residue, and mental states induced in the participants by knowledge of the sweater’s history, such as the sweater serving as a reminder of the deeds perpetrated by the evil person.

Perhaps the most interesting contamination theory in the present context was contamination by spiritual essence, in which the sweater embodied or retained some nonmaterial essence of the person who wore it. Hardly any kind of purification was considered effective for spiritual contamination except for having the sweater worn by an oppositely valenced person. This presumably would replace one form of contamination with another, implying that, once worn, the sweater would always be contaminated, at least by the person who wore it most recently. Spiritual contamination was endorsed by a minority of participants, predominantly for negatively valenced histories. Thus, while all contamination theories, scientifically accepted or not, exemplify some form of property transmission, spiritual contamination is perhaps the clearest case of the property transmission hypothesis being extended beyond its proper bounds under conditions of uncertainty.

Mere association cannot explain these results because contagion does not extend to all objects that are associated with particular individuals. Rozin et al. (1989) asked, quite reasonably, “Why would many individuals become more upset by wearing an innocent-looking sweater that was once worn by Adolf Hitler than by holding a book written about him, with his name and picture all over the cover and the story of his life inside?” (p. 369). The book is clearly strongly associated with Hitler because of the physical attributes described, but the association does not result in a reluctance to handle the book. The difference is that the sweater has had actual contact with Hitler, thereby allowing property transmission to occur, whereas the book has not.

Belief in the transfer of a spiritual essence might seem to be pushing the bounds of rationality. However, this can be interpreted as a case of uncertainty about the limits on the applicability of the property transmission hypothesis. If people have property transmission as a general hypothesis about causality, any specific belief that exemplifies property transmission is more available and easier to believe than any belief that does not involve property transmission, other things being equal. This does not mean that belief in property transmission cannot be replaced by acquired beliefs about specific causal mechanisms, such as mechanisms of infection by viruses. It means just that there is a pervasive bias toward formulating causal hypotheses that conform to the property transmission hypothesis. Transfer of spiritual essence is one such bias, applied in conditions of uncertainty in which falsification is virtually impossible.

Nemeroff and Rozin (1989) presented participants with a body of information about the population of a fictitious island, including information that the people liked to eat one kind of animal (either wild boar or turtle) and that they used parts of another animal (whichever one they did not eat) in tool-making. Participants rated...
members of the population on various trait-rating scales. Some of these had been selected in a pre-experimental rating task as distinguishing the two animals. It was found that participants tended to attribute to the islanders characteristics of whichever kind of animal they ate. For example, the term “irritable” had been judged more characteristic of wild boar than of turtle, and islanders who were described as eating wild boar were judged to be more irritable than those who were described as eating turtle. Thus, participants tended to judge that attributes of animals, even personality traits, were acquired by people who ate them. Both kinds of islanders were described as utilizing both kinds of animals, the only difference being that one species was eaten and the other was used for other purposes. This finding can therefore be interpreted as another instance of property transmission: Characteristics of an animal are transmitted to people who consume it. As Nemeroff and Rozin (1989) pointed out, beliefs of this kind frequently have been reported by anthropologists and appear to be present in diverse cultures. As Nemeroff and Rozin (1989) also pointed out, beliefs of this sort are not always inaccurate: As an example, they stated that ingesting large amounts of fat tends to make one fat. So this might also be a case in which the boundary conditions on the applicability of the property transmission hypothesis are uncertain, and the ready availability of the hypothesis results in a tendency to apply it too widely.

I am not arguing that property transmission is the sole explanation for magical contagion beliefs. Undoubtedly other factors are involved. In the study by Nemeroff and Rozin (1989), magical contagion only occurred for the animal species that was eaten, not for the one used for tool-making, even though the hypothetical islanders would have just as much physical contact with the latter as with the former. In this case, there is something special about eating as a medium for property transmission. This need not be the case, because Nemeroff and Rozin (1994) showed that magical contagion occurs through mere physical contact as well. So the influence of the property transmission hypothesis is moderated by other acquired beliefs about causality. These beliefs may identify mechanisms suitable for property transmission to occur, or they may serve to rule out the possibility of property transmission in specific cases or domains. Even then, the property transmission hypothesis may still exert a covert influence on judgment and belief. It is not likely that many of the participants in the study by Nemeroff and Rozin (1989) would explicitly endorse the belief that “you are what you eat,” but the corresponding judgment emerged in their ratings nonetheless.

As a final example of magical contagion, consider a study by Nemeroff (1995). Participants were asked to imagine a certain person who had influenza and then to draw a picture of what they thought the influenza germ would look like. Target people included liked or disliked others of the participants’ choice. Blind raters judged drawn viruses to be more threatening when the target person was a disliked other than when the target person was a liked other. In a follow-up study, participants did not judge that they were any more likely to catch influenza from exposure to a disliked other than from a liked other, but they did tend to judge that the germs of the disliked other would give them a more severe illness than those of the liked other would. Nemeroff (1995) argued for a magical contagion interpretation of these findings, and they fit with the property transmission hypothesis. In this case, bad characteristics of a person are transmitted to a virus in that person’s system, resulting in an impression that viruses have a more threatening appearance when they come from a disliked person and actually are more threatening in terms of the severity of the illness they cause.

Arguably, this is an example of a widespread version of the property transmission hypothesis that associates it with the evaluative dimension: In essence, good causes good, and bad causes bad. That is, any person, object, or salient feature of an object that is evaluated as positive is likely to transmit positive characteristics to effect objects and vice versa for people or things evaluated as bad. More instances of this version of property transmission appear in the sections to follow.

Illusory Correlation

Illusory correlation is a perception or judgment that two factors or variables are empirically associated when they are not. There are probably several determinants of illusory correlations, and the involvement of causal knowledge is not necessary. For example, Chapman (1967) found evidence for illusory correlation on the basis of semantic association and distinctiveness of stimuli. Participants overestimated the extent to which semantically associated pairs of words such as “bacon” and “eggs” occurred together in a list of pairs of words. They also overestimated the co-occurrence of words that were distinctively longer than other words in the stimulus set, such as “blossoms” and “notebook” in a set in which other words tended to be of four or five letters. However, in some cases, it can be argued that the basis for an illusory correlation is an association derived from a belief in property transmission. That is, property transmission beliefs form a source of associations between putative causes and effects, and belief in those causal relations then results in misperception of empirical association. I shall discuss three examples.

Chapman and Chapman (1967) investigated illusory correlation using a psychodiagnostic tool called the Draw-a-Person Test, in which a patient draws a picture of a human body, and features of the resultant drawings are used to diagnose the patient’s problem. They found judgments of high correlations between symptom descriptions attached to drawings and features of the drawings, although the materials had been designed so that no drawing features correlated with any of the symptom descriptors. For example, participants tended to judge a high correlation between the symptom of worries about manliness and drawings with broad shoulders. They found judgments of high correlations between symptom descriptions attached to drawings and features of the drawings, although the materials had been designed so that no drawing features correlated with any of the symptom descriptors. For example, participants tended to judge a high correlation between the symptom of worries about manliness and drawings with broad shoulders.

Chapman and Chapman argued that perception of correlation was guided by degree of association between the concepts involved. However, the property transmission hypothesis can also account for the results and indeed explains the conceptual associ-
urations. Participants would suppose that people who are worried about how manly they are would tend to have thoughts about their body shape and muscular development to a greater extent than individuals who do not have this worry. They would suppose that these tendencies in thought would tend to be transmitted to drawings produced by these people. Thus, thoughts about muscular development would lead individuals to produce drawn figures with enhanced muscular development because of property transmission. Participants would not be judging correlation by association but judging correlation by a theory of the determinants of drawing characteristics, and that theory is property transmission. Whatever dominates the mental life of the patient is judged likely to be transmitted to drawings produced by the patient.

Property transmission is a theory about how manifest phenomena are produced, and it may therefore underlie belief in many phenomena as indicators of personality characteristics or psychological problems in which conditions of uncertainty make disconfirmation difficult. Take graphology as an example. King and Koehler (2000) reviewed a body of research literature showing that any correlations that might occur between personality characteristics and handwriting features were so weak as to be of no practical utility and were probably beyond the capacity of human judges to detect. They argued that the continuing popularity of graphology as a tool of personality assessment might owe something to the perception of illusory correlations between personality characteristics and handwriting features.

The stimulus materials for their study consisted of 40 samples of handwriting of a standard text, each accompanied by ratings of the writer on seven personality dimensions. In fact, the handwriting samples were randomly allocated to personality profiles, and the average correlation between personality dimensions and the handwriting features of interest was zero. One group of participants assessed the degree of semantic association between personality traits and handwriting features, and another group judged the degree to which they were correlated in the stimulus materials. The judgments made by the two groups were highly correlated, suggesting that semantic association has some relation to the basis on which judgments of correlation were made. The judged correlations, which were unrelated to the objective correlations, closely resembled the relationships identified in the graphology handbooks. As in the case of the Draw-a-Person Test (Chapman & Chapman, 1967), the judgments and beliefs of professionals may reflect the same biases that gave rise to the illusory correlations exhibited in the participants’ judgments.

These illusory correlations can also be explained by the property transmission hypothesis. In this case, it is features of personality characteristics that are believed to be transmitted to behavior. For example, for the variable of speed of handwriting, participants tended to associate fast writing with impulsive personality and slow handwriting with cautious personality. These represent ways in which impulsivity and cautiousness would be assumed to affect handwriting: To the extent that impulsive individuals are believed to be quicker in behavior, decision making, and so on than cautious individuals, these characteristics would be transmitted to individuals’ handwriting as well, resulting in faster handwriting. For the variable of rhythm, participants tended to associate regular handwriting with reliable personality and irregular handwriting with unreliable personality. In this case, to the extent that reliability has connotations of steadiness and predictability, these characteristics would be judged likely to be transmitted to handwriting, lending it a steady, predictable, in other words, regular appearance. To the extent that unreliability has connotations of unpredictability and capriciousness, these characteristics would be judged likely to be transmitted to handwriting, resulting in irregular rhythm.

Similar arguments can be made for most of the handwriting characteristics studied by King and Koehler (2000). The exception is the pairing of shape (angular vs. rounded) with analytical versus intuitive personality. It is not clear how an analytical personality would produce an angular appearance in handwriting by property transmission or how an intuitive personality would produce a rounded appearance. This was the weakest of the illusory correlations investigated by King and Koehler (2000); even so, it indicates that property transmission is unlikely to provide a complete explanation for the illusory correlations found. The superficial explanation for many, if not all, cases of illusory correlation is semantic association: Both Chapman and Chapman (1967) and King and Koehler (2000) found that semantic association judgments were good predictors of illusory correlations. However, the point is to elucidate what accounts for the semantic associations that exist between concepts, and belief in property transmission is one mechanism for this.

The two cases discussed so far have both involved individual characteristics as supposed causes of individual behavior. The third case involves objective events and circumstances as supposed causes of mental states. Kammann and Campbell (1982) investigated illusory correlations in judgments about correlates of stable long-term happiness (hereafter referred to as just happiness for short). Kammann and Campbell observed that although there are many beliefs about what predicts happiness, research had uncovered only weak relationships with objective variables, and the relationships found did not always match up with common sense beliefs. Several variables, including health and number of friends, did not appear to predict happiness at all, and for others, such as family income and level of education, the objective correlation was low. These findings set the stage for a study of illusory correlation in relation to happiness.

Kammann and Campbell (1982) began by investigating beliefs about causes of happiness. They selected three factors that were judged to be strong causes of happiness, friends, health, and income, and a fourth, education, that was judged to be a positive but weaker cause. These four will be called the popular factors. Factors about which no particular belief emerged will be called neutral. Participants in the illusory correlation study were presented with information about 16 fictitious married men, half described as happy and half as unhappy. For each man, the materials included information about two of the popular factors and two neutral factors. The objective correlation between the popular factors and happiness was always zero; that for the neutral factors was -1 in one condition and +1 in another. Each factor appeared eight times altogether. Participants judged the extent to which each factor was correlated with happiness in the stimulus materials. Illusory correlations occurred for the three main popular factors, with a weak tendency in the direction of illusory correla-

\[1\] This was the case when that research was carried out, but more recent research has uncovered some objective predictors of happiness, such as amount and quality of contact with friends (Myers, 1999).
tion for the fourth popular factor, education. Participants were able to detect the objective correlations for the neutral factors.

The property transmission hypothesis can account for the illusory correlations for the three main popular factors. The salient feature of happiness is its evaluative connotation: Happiness is good or pleasant, and unhappiness is bad. So one should look for a possible cause that has an obvious corresponding location on the evaluative dimension. The three main popular factors all satisfy this requirement. Health would be evaluated by most people as good; indeed, good health and bad health are normal ways of identifying one’s standing on that dimension. Having friends is good; lack of friends is not good. Having money or a high income (again, often described as a good income) is good, while having low income or few resources is not good. Under the property transmission hypothesis, good circumstances will tend to be transmitted to the state of mind of the individual who has them, and so will bad circumstances. Thus, good standing on health, friends, and income causes good standing on the happiness dimension, and bad standing on the three factors causes bad standing on the happiness dimension.

The factors that were investigated in the initial study but not judged to be causes of happiness included age, sex, ethnic group (the study was carried out in New Zealand, and this was a Maori vs. European comparison), and religiosity. It is less clear how each of these factors would relate to the evaluative dimension. However, there was one factor, physical attractiveness, that would probably be judged as having a clear relation, with attractiveness being judged as good and unattractiveness being judged as not good. It therefore seems likely that the property transmission hypothesis fails to explain why physical attractiveness was not judged to be a cause of happiness. One possibility would be that people have further beliefs that moderate a tendency to judge in accordance with the property transmission hypothesis in this case, but in the absence of further research this must remain a conjecture.

The property transmission hypothesis does not cover the mechanism by which illusory correlations emerge in judgments. It is an account of the origin of some of the beliefs that are represented in illusory correlations. There may be several mechanisms involved in the generation of illusory correlations in judgmental processes (see, for example, Fiedler, Hemmeter, & Hofmann, 1984); property transmission is proposed here merely as a source of beliefs that enter into the mechanisms that generate illusory correlations in judgment.

Personal Characteristics and Behavior

Causal powers are seen as stable, enduring properties of the objects that possess them. As such, they confer a degree of predictability on the outcomes in which they are involved. Stones consistently tend to break windows when they hit them, rather than changing their color, or sometimes breaking them and sometimes changing their color, because the causal powers of stones are qualitatively specific and endure with little or no change from one occasion to another (White, 1989). To the extent that this is believed to be true of the causal powers of individuals, the behavior of those individuals will also tend to be judged as consistent and predictable from one occasion to another. Therefore, under the property transmission hypothesis, human behavior tends to be seen as reflecting the causal powers of the actor and tends to be seen as consistent and predictable because the causal powers of the individual are stable and enduring. For example, if an individual is judged to have a kind disposition, this disposition functions as a causal power that tends to produce kind behavior through property transmission and exerts a pervasive influence toward consistency in that individual’s behavior on the kindness dimension.

This reasoning about the property transmission hypothesis generates at least four predictions for judgments, predictions, and attributions about human behavior:

1. Through the property transmission hypothesis, behavior should be seen as resembling the relevant causal powers of the actor. Thus, if behavior is known, then there will be a tendency to infer a causal power that resembles the behavior on the grounds that the causal power tends to transmit its properties to the behavior. Also if the causal power is known (or believed), then there will be a tendency to predict behavior that resembles the power for the same reason.

2. To the extent that behavior is seen as the product of property transmission, high cross-situational consistency in behavior related to the causal power in question should be predicted.

3. To the extent that behavior is seen as the product of property transmission, different behaviors that express the same underlying causal power should be seen as highly correlated across individuals.

4. To the extent that behavior is seen as the product of property transmission, there will be a tendency to neglect other objectively relevant factors in making behavioral predictions, such as regression effects.

The generality of these predictions is qualified by the influence of other factors. It is possible for people to acquire domain-specific knowledge that functions to moderate the influence of the property transmission hypothesis on judgment. Enculturation is an example in which the tendency to judge in accordance with the property transmission hypothesis can be overridden by the acquisition and application of culture-specific and domain-specific beliefs. An example will be briefly discussed in the next section. However, the claim here is that the influence of causally important factors that do not (or are not believed to) operate by property transmission will tend to be underestimated, particularly under conditions in which implicit reasoning is more likely to influence judgments, such as under conditions of cognitive load. Thus, the impact of culture-specific beliefs about the importance of situational factors in behavior, for example, will tend to be underestimated, particularly under conditions of high cognitive load.

Prediction 1: Correspondence Between Causal Powers and Behavior

There is abundant evidence that people tend to infer causal powers that resemble observed behavior. This is especially the case when behavior is presented as having been freely chosen, such as an individual choosing what position to take when writing
an essay on a controversial topic (Jones & Harris, 1967; Steiner & Field, 1960) and when the behavior observed departs from a relevant norm (Jones & Davis, 1965). Even when behavior is presented as not being freely chosen, corresponding causal powers still tend to be inferred. This is the tendency generally known as the correspondence bias (Gilbert & Malone, 1995; Jones & Harris, 1967; Ross, 1977; Ross & Nisbett, 1991). Much of the evidence for the correspondence bias has come from studies based on an original by Jones and Harris (1967). In that study, participants read an essay on an attitude-relevant topic, supposedly written under conditions of no choice. That is, the attitude taken in the essay had been assigned to the writer. Under this circumstance, the content of the essay should not be taken as indicating the writer’s attitude, but many studies have shown that participants do tend to infer that the writer’s attitude corresponds to the content of the essay and that this tendency is remarkably resistant even in the face of overwhelming evidence that the writer’s position was forced on him or her (Gilbert & Malone, 1995; Ross, 1977).

Many explanations have been proposed for this correspondence bias (Ajzen, Dalto, & Blyth, 1979; Choi, Nisbett, & Norenzayan, 1999; Fleming & Darley, 1989; Gilbert & Jones, 1986; Gilbert & Malone, 1995; Gilbert, Pelham, & Krull, 1988; Heider, 1944, 1958; Ichheiser, 1943; Jones, 1979; Kuklik, 1983; Miller, Schmidt, Mayer, & Colella, 1984; Quattrone, 1982; Ross & Nisbett, 1991; Tetlock, 1985; Trope, 1986). This is not to argue that any of them is wrong; very likely correspondence bias, like illusory correlation, is an overdetermined phenomenon. However, I would argue that the tendency can be interpreted as a straightforward consequence of the property transmission hypothesis.Inferring an attitude from the content of an essay is a case of judgment under uncertainty. In this circumstance, the property transmission hypothesis functions as a heuristic and generates a judgment that the content of the essay reflects the properties of the causal power of the individual, which in this case is an attitude. Thus, by application of the property transmission hypothesis, it is inferred that the writer’s attitude resembles the position advocated in the essay. Other relevant factors are not necessarily ignored. In the original study by Jones and Harris (1967), the mean attitude inference in the no-choice condition was less extreme than that in the choice condition, indicating that the choice factor was not completely neglected. However, the property transmission hypothesis results in overestimation of the degree to which the relevant causal power resembles the observed behavior, which is not sufficiently corrected by knowledge of the situation.

This account complements and fills out other hypotheses that have been proposed. Gilbert and Malone (1995) argued that the correspondence bias emerges from a process of inference with three stages. In Stage 1 the behavior is identified; this corresponds to reading the essay and identifying the position advocated in it. In Stage 2, the actor is automatically characterized in terms of the behavior identified. In the essay task, this would mean inferring that the writer’s attitude corresponds to the attitude expressed in the essay. In Stage 3, salient situational factors are taken into account, and the inference about the actor’s personal characteristic is moderated accordingly. The difference between Stages 2 and 3 is not merely one of temporal order. Stage 2 is supposed to be an automatic process of inference, which means that it occurs whenever behavior is observed and is not subject to choice or deliberation. Stage 3, on the other hand, is supposed to be accomplished through higher order cognition, which is effortful and consumes cognitive resources.

Why should Stage 2 be attitude attribution rather than situation appraisal, and why should Stage 2 be automatic rather than effortful? The property transmission hypothesis offers an explanation. Property transmission is a fundamental and general theory about causal relations and therefore functions as a simple and intuitive first guess about the causal interpretation of an outcome. A parallel can be drawn with the infant causal perception research discussed earlier: Infants first get the idea that the size of the outcome should correspond to the size of the causal object and only later learn to take properties of the effect object into account (Kotovsky & Baillargeon, 1998; Wang et al., 2003). In the same way, behavior is initially interpreted in terms of inner causal powers because of the fundamental understanding of causation in terms of property transmission, and then the interpretation is adjusted in the light of other salient information. As Gilbert and Malone reported, the correspondence bias is enhanced under conditions of high cognitive load, which is consistent with the proposal that causal factors that do not operate by property transmission are more likely to be neglected under high cognitive load.

The extent to which use of the property transmission hypothesis is moderated by other relevant information depends on many factors, including enculturation. Choi and Nisbett (1998) showed that when situational constraints were made salient, Korean participants exhibited less of a correspondence bias than American participants. However, when situational constraints were not salient, the correspondence bias was equally prevalent in both groups of participants. This finding adds weight to the argument that the tendency to assume property transmission is fundamental and that acquired domain-specific beliefs moderate application of the property transmission hypothesis to an extent that varies depending on enculturation.

Prediction 2: Prediction of High Cross-Situational Consistency in Behavior

To the extent that the causal powers of an individual are believed to be transmitted to that individual’s behavior, the behavior of the individual on the dimension relevant to a given causal power should be predicted to be highly consistent across situations. There is evidence for this from several studies.

Kunda and Nisbett (1986) informed participants that Person A was more friendly than Person B in one situation and asked them to estimate the likelihood that Person A would also be more friendly than Person B in another situation. For behaviors for which research evidence suggested that the objective cross-situational consistency corresponded to a correlation of about .2, participants’ mean estimates corresponded to a correlation closer to .8. Norenzayan, Choi, and Nisbett (2002) ran a similar study with a cross-cultural comparison between American and Korean participants. Both groups gave similar and high judgments of cross-situational consistency. In view of the evidence that Koreans do take situational factors into account in attributional contexts when they are salient (Choi & Nisbett, 1998), this is a further indication that the property transmission hypothesis represents a general and fundamental tendency and that moderating it by taking note of relevant situational information is an acquired tendency that is not applied in all relevant contexts.
There is a problem with the methodology of these studies, in that participants were not given any additional information about either the situations or the people. Having no informational basis for making a prediction about Situation X other than behavior observed in Situation Y, it is not very surprising that predictions were strongly based on the information about Situation Y. In an unpublished study by Newton, Griffin, and Ross, described by Ross and Nisbett (1991), the investigators addressed this problem by providing relevant situational information. One group of participants (the “contributors”) was given the opportunity to contribute to a food drive. Half of these participants had previously been judged by their peers (the “nominators”) as least likely to contribute, and half as most likely. Within each subgroup, half of the participants were subjected to a manipulation designed to elicit contributions. This manipulation included being sent a personalized letter in which they were asked to contribute a particular food and were given detailed directions on how and where to make their contribution. The other half were sent an impersonal letter with little information about how to make a contribution. The nominators were told about these situational factors and were asked to predict the likelihood of contributors making contributions. Their predictions were strongly influenced by whether the contributors were in the least-likely- or most-likely-to-contribute group but hardly at all by the situational information. In fact, the situational manipulation accounted for more of the variance in contribution-related behavior than the judged personality characteristics of the contributors did. This study therefore adds to the evidence that people expect high levels of consistency between personality characteristics and behavior, even when they are in possession of relevant situational information.

People are capable of making accurate predictions about cross-situational consistency. Kunda and Nisbett (1986) showed this capability in one of their experiments, and Epstein and Teraspulsky (1986) showed that people are capable of at least ordinal levels of accuracy, correctly predicting that some trait-related behaviors show more cross-situational consistency than others. The property transmission hypothesis does not predict that such judgments will invariably be erroneous; rather, it predicts a general tendency to predict high levels of cross-situational consistency, whether they occur or not, and it predicts that when error in judgment does occur, it will be on the side of predicting too much consistency rather than too little. As in the other cases discussed here, it is possible for a fundamental tendency toward application of the property transmission hypothesis to be moderated by acquired beliefs; however, the research discussed here shows that the tendency to predict high levels of consistency is not significantly moderated by knowledge of either the individuals concerned or relevant situational factors.

**Prediction 3: High-Judged Correlations Between Similar Behaviors Across People**

Jennings, Amabile, and Ross (1982) presented participants with a set of pairs of behavior descriptors and asked them to judge the level of correlation between the members of each pair across a sample of individuals. They then compared mean judgments with objective data. In this situation, the property transmission hypoth-
it is hard to see his interpretation as being complete without this causal component.²

In general, then, the property transmission hypothesis predicts that judged correlations between behavior descriptors should increase as it becomes increasingly plausible to regard them as derived from the same underlying causal power. The results of the studies by Jennings et al. (1982) and Shweder (1977) are consistent with this, but clearly further research is needed.

**Prediction 4: Neglect of Regression Effects in Behavioral Prediction**

Kahneman and Tversky (1973) presented groups of participants with information about hypothetical students and asked for two judgments, evaluation and prediction. For evaluation, participants were asked to judge how the students stood in relation to their peers. For prediction, participants were asked to judge the students’ future examination performance. Kahneman and Tversky argued that the prediction judgment carries greater uncertainty than the evaluation judgment. There are, after all, many factors that might influence a student’s performance in the future, and many ways in which the student might change between the two times. They therefore argued that prediction judgments should exhibit a regression effect by comparison with the evaluation judgment. In fact, no evidence of a tendency to regress predictions toward the mean, by comparison with evaluation judgments, was found.

Why should this happen? In this case, the stimulus information is equally relevant to both the evaluation and prediction judgments. Under the property transmission hypothesis, the prediction of future performance should be based on the information about the student that is judged relevant to determining future performance. The student’s ability, for example, is judged to determine future performance by property transmission just as it determines the student’s current standing with respect to other students. To the extent that the property transmission hypothesis dominates judgments, other causally relevant factors will tend to be neglected. So, under the property transmission hypothesis, predictions should not show regression effects.

In a further study, Kahneman and Tversky (1973) asked three groups of participants to predict future examination performance of students from information about a single score. One group was told that the score represented the students’ first year undergraduate academic achievement. A second group was told that the score was the result of a test of mental concentration. They were told that scores on this test correlated with final examination performance but were also affected by transitory state variables. The third group was told that the score was the result of a test of sense of humor and that it was not possible to predict final examination performance from this measure.

The second group was given information that would provide a rational justification for introducing regression into their predictions, but their predictions did not show any regression effect, whereas those of the third group did. The property transmission hypothesis predicts this result as well. To the extent that a test measures capacities relevant to examination performance, people will judge that examination performance should correspond to the score obtained on the test because both are determined by the same underlying characteristics. That is, those characteristics tend to determine both kinds of performance by property transmission, and so performance on one should be taken as highly predictive of performance on the other.

Kahneman and Tversky (1973) interpreted their results as exemplifying the representativeness heuristic. Kahneman and Tversky (1972) defined this heuristic as “the subjective probability of an event, or a sample, is determined by the degree to which it: (i) is similar in essential characteristics to its parent population; and (ii) reflects the salient features of the process by which it is generated” (p. 430). Clearly, there is no incompatibility between this definition and the property transmission hypothesis. Where the property transmission hypothesis is applied, an event has the characteristics of its cause, and in that sense, it would be true to say that it reflects the salient features of the process by which it was generated. The property transmission hypothesis is not a competitor to the representativeness heuristic as an explanation for non-regressive predictions. Instead, it helps to explain why similarity is used as a heuristic for certain kinds of judgment, under the hypothesis that similarity is generated by property transmission. Those instances of use of the representativeness heuristic that involve generative processes or causal relations believed to be characterized by property transmission can be more fully accounted for by the proposition that property transmission is the causal hypothesis involved in the generation of judgments. The nonregressive prediction studies are two examples of this proposition.

**Perspective on Causal Relations Between Inner Characteristics and Behavior**

The theme of this section has been that people make judgments in accordance with a general belief that stable, enduring causal powers of people, such as personality characteristics, attitudes, and abilities, tend to determine features of behavior by property transmission. To the extent that the property transmission hypothesis dominates judgments, it implies neglect of other relevant determinants of behavior such as situational factors, and results in the four judgmental tendencies described earlier.

Among alternative possible theories of behavior, people could operate with a belief that the most causally dominant characteristics of people are inherently unstable, so that their behavior, although caused by inner characteristics, varies unpredictably across times and situations. There is little evidence for such a

² Shweder’s explanation was that propositions about likeness tend to be confused with propositions about co-occurrence likelihood. This explanation does not call specifically on causal knowledge, and in fact Shweder focused mainly on conceptual similarity without discussing whether instances of conceptual similarity could be interpreted in terms of property transmission. One cornerstone of Shweder’s hypothesis was that likeness judgment is intuitive and correlation judgment is not, and so likeness substitutes for covariation assessment in many cases. At that time, the evidence from studies of covariation seemed to support Shweder’s position (e.g., Smelshlundi, 1963), but subsequent research has shown that people are rather more competent at contingency judgment than was then apparent (e.g., Wasserman, Elek, Chatlosh, & Baker, 1993). Therefore, while there could still be a case for arguing that causal judgments tend to be based more on similarity judgments than on covariation assessment, it is less plausible that the argument could be justified by the claim that covariation assessment is nonintuitive.
theory. Indeed, the whole of attribution theory has been based on the premise, first explicitly articulated by Heider (1958), that people primarily seek stable dispositional properties (of either people or objects or circumstances) that render behavior both comprehensible and predictable. White and Younger (1988) showed that the stable cause theory dominates more in attributions about others than in self-attributions. While people described others mainly in terms of traits, they described themselves mainly in terms of thoughts and feelings. When presented with a trait ascription task that included an option stating that expression of a trait depended on mood, the mood option was endorsed significantly more often for self than for others. To some extent, then, the stable cause theory is one that people apply to others more than to themselves. However, this isolated finding does little to detract from the general impression that attribution is predominantly concerned with identifying the stable inner causal powers of people that are transmitted to behavior, thereby giving it consistency and predictability.

A study by Millar (1984) provides an insightful developmental perspective on this finding. Actors who were described as either “nice” or “bad” were said to have acted in a way that led to either a good outcome or a bad one. At both 7 and 9 years old, children tended to judge that the action was intentional (i.e., that the actor intended the outcome that occurred) when there was a match between the characteristic of the actor and that of the outcome: Nice actors were judged to intend good outcomes, and bad actors were judged to intend bad outcomes. When there was a mismatch between actor and outcome, children tended to judge that the outcome was not intended. This comes at a time when children are just learning to be trait theorists (Rhodes & Ruble, 1984, 1986; White, 1995; Yuill, 1992).

The study shows that children expect stable inner characteristics to be transmitted to behavior (i.e., to produce behavior that resembles the content of the characteristic) and that intentions are the causal route through which property transmission operates. More than that, it provides early evidence of a specific but widely applicable version of property transmission, namely that good powers produce good behavior and outcomes, and bad powers produce bad behaviors and outcomes. Examples of this theory in operation have already been given. Its pervasiveness is further indicated by a body of research showing that physically attractive individuals tend to have positively evaluated personality characteristics attributed to them more than physically unattractive individuals do. The results of a study by Dion (1972) constitute an almost direct parallel with Millar’s (1984) developmental study.

The study investigated how adults dealt with a violation of the relation between attractive appearance and good behavior. A bad deed committed by a child was described, and participants were presented with a portfolio of information about the child, which included a photograph showing either a physically attractive child or a physically unattractive child. When the deed described was sufficiently extreme that it could not be described as anything other than bad, participants who saw a physically attractive child tended to infer that the deed reflected a temporary bad mood and not a chronically antisocial condition. Participants who saw a physically unattractive child tended to do the opposite. They also ascribed more negative traits (such as dishonesty and unpleasantness) to the unattractive child than to the attractive child. The results are therefore evidence for the same theory that emerged in Millar’s (1984) study: Good people do (and intend) good things, and bad people do (and intend) bad things. Physical attractiveness is just taken as an indicator of the valence of the traits one possesses.

This theory applies not just to social behavior but to behavior of any kind. In a study in which children fired toy ray guns at targets of different colors, Shultz and Wells (1985) found evidence that from the age of 3 years, children judge the intentionality of an outcome of action on the basis of matching to the outcome. If the outcome (a light going off behind one of the colors) matched the stated intention (which color the shooter was aiming for), then it was judged to have been produced intentionally. If outcome and intention did not match, then the outcome was judged as not intended. Shultz and Wells investigated several other rules for identifying outcomes as intentional, but the children used none of them consistently until the age of 11 years. Fundamentally, then, children judge that intentions tend to influence behavior by property transmission and that if an outcome occurs that does not resemble what is known about the content of an intention, they judge it not to have been intended.

There is therefore a good deal of evidence that people possess a general understanding in which both stable inner characteristics and intentions tend to influence behavior and outcomes of behavior by property transmission. The property transmission hypothesis is moderated, but not disconfirmed, by evidence of mismatches between inner characteristics and behavior. An outcome of behavior is judged not to have been intended if it does not resemble the causally relevant inner characteristic of the actor, and salient situational information can moderate the tendency to ascribe a correspondent personal disposition to an actor (Choi & Nisbett, 1998). However, these qualifications and moderations take place against a background of general belief in property transmission, so the resultant tendency is to interpret behavior as reflecting the transmission of inner characteristics to a greater extent than is likely to be the case.

The Act of Will as an Illusory Cause of Action

Discussion of the relation between intentions and behavior leads to the last major topic to be addressed here. Most of us have some kind of belief that we produce our own actions through something like an act of will that follows some kind of thought or intention about what our action will be. The precise form of this lay understanding in which both stable inner characteristics and intentions tend to influence behavior and outcomes of behavior by property transmission remains to be elucidated, but the brief sketch just given can be regarded as a reasonable approximation to it (Wegner, 2002, 2003; White, 1993).

Several lines of research are casting increasing doubt on this theory of the production of actions. These include evidence for neural events antecedent to actions occurring reliably prior to the reported act of will that supposedly was involved in producing the behavior (Kukleta & Lamarche, 1996, 1998, 2000; Lamarche, Louvel, & Buser, 1998; Libet, 1985; Trevena & Miller, 2002) and evidence for the influence of priming manipulations on apparently voluntary actions (Bargh & Chartrand, 1999; Bargh & Ferguson, 2000). I focus here on research by Wegner and colleagues because Wegner’s (2002, 2003) model of the production of action is designed to account for the illusion that acts of will cause actions, and this model provides a useful perspective on the property transmission hypothesis.
In several studies, Wegner and colleagues have shown that individuals tend to interpret certain events as outcomes of their own intended actions when in fact they were not. I shall take a study by Wegner, Sparrow, and Winerman (2004) as an illustration. In this study, either two participants or one participant and an experimenter adopted a “helping hands” configuration, in which the participant’s hands were inactive and the helper’s hands passed through the sleeves of a smock worn by the participant, so that they appeared in roughly the position the participant’s own hands would normally occupy. Both parties wore headphones, and instructions about specific hand movements were issued to the helper. Participants reported higher judgments of control of the helper’s actions when they heard these instructions than when they did not. Thus, correspondence between the content of the instructions heard by the participant and the action performed by the helper resulted in the participants being more likely to judge that they had some causal role in the action when in fact they did not.

Studies such as this can be interpreted in terms of the use of the property transmission hypothesis to guide judgments about intentional and control of behavior. However, there is more to the involvement of the property transmission hypothesis than that. Wegner (2002, 2003) argued that the results show that the belief that behavior is caused by conscious acts of will is an illusion. He proposed a model to account for the occurrence of this illusion. In this model, an unconscious cause of thought leads to an unconscious cause of action that leads to action. The unconscious cause of thought also leads to a conscious thought, identified with the act of will. However, it is the unconscious cause of action that actually produces the action, and the conscious act of will is a causally ineffective byproduct of the causal sequence leading to action.

Wegner argued that the conscious act of will is wrongly interpreted as the cause of action because it meets Humean criteria for causal identification: It is reliably empirically associated with the action, it is temporally contiguous and occurs prior to the action, and there are no other apparent causal candidates. This last is the case because the true causes of action are nonconscious and therefore not available to the higher inferential processes that generate beliefs about causes of action. Because of this erroneous inference to the wrong theory, errors of judgment about the intentionality of actions can occur, as illustrated by the helping hands study.

That analysis overlooks the importance of the property transmission hypothesis. The content of the act of will that is taken to be the cause of action resembles the content of the action (or its outcome), and the act of will will not be interpreted as the cause of action if this is not the case. If the content of my act of will is that I am going to pick up an apple, it is a condition for accepting the act of will as a cause of the action that I actually do pick up the apple in question. If I picked up the pear sitting next to the apple, I would not regard my act of will as the cause of that. Part of our theory about the causal relation between acts of will and actions, then, is that the content of the act of will determines the content of the action by property transmission. Resemblance is not a Humean criterion for causal identification, but it must be at least part of what is involved in the identification of acts of will as causes of behavior.

So pervasive is the property transmission hypothesis in regard to acts of will that it can even lead to a kind of magical contagion belief in which the contents of one’s thoughts and acts of will influence outcomes for others, even when they do not find expression in one’s own behavior. Pronin, Wegner, McCarthy, and Rodriguez (2006) conducted an experiment in which participants were induced to stick pins into small dolls representing a disliked person, while thinking either evil or neutral thoughts about the person. The person in question, who was a confederate, then reported that he had developed a headache. Participants who had been thinking evil thoughts were more likely to judge that they had some causal responsibility for the headache than those who had been thinking neutral thoughts. As Pronin et al. pointed out, both groups of participants observed the same correlation between their behavior and the confederate’s headache. What made the difference must therefore have been the resemblance between the content of the thoughts and the outcome for the confederate, which was high in the evil-thought condition and low in the neutral-thought condition. Participants seem to have judged that their thoughts influenced the state of the confederate by property transmission.

In a second experiment, participants observed a blindfolded confederate shooting basketballs at a hoop. On some trials, participants were instructed to generate positive visualizations involving the confederate succeeding at scoring a basket, and in others they were not. Both the participants themselves and observers tended to judge that the participants’ positive visualizations had a positive effect on the shooter’s performance. Here too is salient resemblance between the content of the positive visualization and the outcome for the confederate, which was obviously not the case in the absence of positive visualization.

These experiments bring us full circle, back to magical contagion. People judge that their own thoughts and acts of will have some causal responsibility for both positive and negative outcomes experienced by another person by property transmission, even though there is no apparent mechanism or route whereby such influence could be transmitted. This application of the property transmission hypothesis is definitely in error because the outcomes in each case were generated by the confederate who was acting under instruction from the experimenter. In the same way, but in the other direction, people apparently believe that the powers of an evil person can contaminate a garment to the point that they would be reluctant to wear it and that contamination occurs, in some cases at least, by transfer of some nonphysical property through property transmission.

If this extension to Wegner’s model of acts of will and action is right, then the property transmission hypothesis can truly be described as pervasive because it is applied more or less automatically in the interpretation of virtually all acts of will by virtually everybody. The further extension to judgment that one’s own acts of will influence outcomes for other people can be regarded as a consequence of the use of the property transmission hypothesis as

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3 The fact that there have been counterarguments to Wegner’s theory (Nahmias, 2005, and see replies to Wegner, 2004) and that this is currently an area of active controversy does not undermine the claims about the role of the property transmission hypothesis proposed here: Whether humans have volition or will or not, resemblance between an outcome of action and the content of a supposed mental antecedent to action is necessary to any claim that that antecedent has a causal role in producing the action. If there is an illusion of conscious will, whatever may be the explanation for it, the property transmission hypothesis plays a key role in maintaining it.
a heuristic under conditions of uncertainty. Under such conditions, property transmission is a fundamental and general causal theory that is all too easily applied as a heuristic beyond its proper bounds.

Other Possible Cases of Use of the Property Transmission Hypothesis

I have discussed in some detail five areas in which a case can be made for the property transmission hypothesis influencing judgments. There are many others in which a case could be made, but little relevant research has been carried out. What follows is a collection of likely examples, on which further research might be able to shed more light.

Mill (1843/1974) accepted that “the cause does, in very many cases, resemble its effect” (p. 766) and discussed some examples, a few of which were quoted in the introduction. However, he argued that the hypothesis of resemblance between cause and effect was often applied beyond its proper bounds, even in science. For example, “the early speculations respecting the chemical composition of bodies were rendered abortive by no circumstance more, than by their invariably taking for granted that the properties of the elements must resemble those of the compounds which were formed from them” (p. 767). Education in chemistry today soon reveals that the properties of compounds often resemble none of the properties of their constituent elements. However, there is evidence that children might start by assuming that property transmission occurs in chemical reactions and that this assumption may be superseded by subsequent education.

Shultz and Ravinsky (1977) showed children a beaker of clear liquid. The experimenter added solution from a pink dropper bottle and from a blue one, whereupon the liquid in the beaker turned pink. In the absence of other cues (contiguity, covariation), children between 6 and 12 years old tended to identify the solution from the pink bottle as the cause of the change in the color of the liquid. When the similarity information clashed with covariation information, older children judged by the covariation cue, but younger children showed no consistent preference. This is an isolated study that does not appear to have led to any further research, and much may depend on the specifics of the testing situation. However, the results may show a tendency for the property transmission hypothesis to guide judgments about chemical reactions, at least up to an age at which children have mastered the use of covariation as a cue to causal inference sufficiently to rely on it in preference to similarity. This could also reflect education, in that by the age of 12 years, children may have learned that similarity is not a reliable guide to causal identification in chemical reactions.

To continue with Mill (1843/1974), he observed that early scientists also supposed that “motion was caused by motion, by something like itself” (p. 768). As an example, Mill took the early theory that the voluntary motions of the human body were effected by vibrations propagated along the nerves connecting brain and body.

In the like manner, it was supposed that the physical qualities of objects must arise from some similar quality, or perhaps only some quality bearing the same name, in the particles or atoms of which the objects were composed; for example, it was believed that a sharp taste must arise from sharp particles. And reversing the influence, the effects produced by a phenomenon must, it was supposed, resemble in their physical attributes the phenomenon itself. The influences of the planets were supposed to be analogous to their visible peculiarities: Mars, being of a red color, portended fire and slaughter and the like. (p. 768)

These examples show how natural it is to suppose that natural processes are governed by property transmission until the evidence of research proves otherwise. Thus, the property transmission hypothesis may exert an influence on the kinds of hypotheses formulated in science, such that hypotheses that do not exemplify property transmission are less likely to be formulated until progress in research leads toward them.

This may be exemplified by the body of research known as the New Look in perception. This term refers to a school of thought according to which internal states such as attitudes, values, expectancies, needs, and emotions influence visual perception of external stimuli (Bruner & Postman, 1947a, 1947b; Erdelyi, 1974). Typical examples would be a tendency for poor people to perceive coins as being larger than do richer people (because of the greater subjective value of coins to poorer people) and for hungry people to have a reduced threshold to the detection of food-related words in tachistoscopic presentations. This is not to argue that the hypotheses investigated in New Look research are false, merely to point out that the property transmission hypothesis may have played a role in the formulation of the hypotheses. To the extent that property transmission is a fundamental and general theory of causation, it is easier to think of hypotheses that exemplify property transmission than hypotheses that do not. This is not dissimilar to the reasoning proposed earlier in the case of illusory correlation. Diagnostic tests may have signs that are valid indicators of particular pathologies, but the signs often do not resemble the symptoms they indicate, and in consequence they tend not to be detected by participants in illusory correlation studies (Chapman & Chapman, 1967, 1969). It is easy to hypothesize that hunger might alter the detectability of food-related words because of the resemblance between the two things: thoughts of hunger in some way influence the perceptual impression by property transmission, facilitating the detection of food-related words. However, it would be much less easy to hypothesize that hunger might alter the threshold for detection of names of trees, for example, because the property transmission hypothesis suggests no connection between them. When we seek hypotheses to test in a new field in which much is unknown, the property transmission hypothesis provides our initial guide.

Marks and Kammann (1980) documented many instances of apparent evidence for paranormal phenomena that depended on the detection of similarities that were supposed to be causally relevant. One pervasive theme running through their account concerned the power of what they called oddmatches. Oddmatches are coincidences but specifically coincidences that have no explanation accepted by science. An example would be dreaming that a certain event occurred and then witnessing that event the next day. Some people accept that events of this kind are chance occurrences. Others interpret them as causally connected by a paranormal mechanism, such as the ability to see into the future.

Marks and Kammann (1980) argued that some oddmatches are interpreted as evidence for paranormal phenomena because people tend to underestimate the chance likelihood of coincidences oc-
curring. Part of the aim of research into the paranormal is to obtain objective computations of likelihood in order to show that certain phenomena could not be explained as chance occurrences. An example is remote sensing (Targ & Puthoff, 1974, 1977). In a remote-sensing experiment, one experimenter and some observers travel to a secret target location where they wander around looking at things. Another experimenter and the remote-sensing participant remain in a Faraday cage in a laboratory. The remote sensor aims to pick up images of what the observers are seeing and records them on audiotape or in drawings. The same procedure is repeated for a series of targets, resulting in a set of pairs of target locations and transcripts of remote-sensing recordings. An independent judge, ignorant of the true pairings of location and report, then visits all of the locations and rank orders the transcripts according to the match between features in the transcripts and features of the locations. Highly statistically significant results were obtained with this procedure, which were interpreted as showing that the remote-sensing participant was somehow picking up information about what the observers were seeing.

Marks and Kammann were able to show that the significant results occurred because the transcripts contained clues that the judges could use to match transcripts to locations. The point of relevance to the present account is that the situation fits the three criteria outlined in the introduction for the inference of property transmission. Activity is certainly going on, because human actions are involved in both the visit to the locations and the performance of the remote-sensing participant. There are also cues to generative transmission; principally, the participant reports experiences that have the subjective appearance of perceptions, consistent with the transmission of sensory data from one location to another. Most important, the outcome is the appearance in the transcripts of properties that were not there before this supposed interaction took place, namely, the features in the transcripts that match features of the locations. Because of this matching, property transmission is an intuitively appealing interpretation of the phenomenon. Because no ordinary perception could account for the matching, extraordinary, paranormal perception is invoked to explain it.

Marks and Kammann pointed out that once the independent judge knew which transcript went with which location, it would have been easy for him to scout around the location and find features that matched those in the transcript simply because most locations had many and complex features. In effect, the judge would have engaged in a form of positive instance testing, under the hypothesis that features of locations seen by observers were transmitted to the remote-sensing participant and thereby producing salient similarity between the locations and the transcripts. In that way, the property transmission hypothesis would function as a bias in judgments made under conditions of uncertainty. Without that bias, the judgments that yielded the apparent evidence for remote sensing would not have been made.

Nisbett and Ross (1980) cited several examples of commonly held causal beliefs:

[Political] radicalism and nonconformity are attributed to the “permissiveness” in child rearing practiced by a generation of parents tutored by Dr. Spock; sex crimes are attributed to the accessibility of pornography to youths; and adult maladjustment is attributed to childhood trauma. (p. 118)

These are particularly telling examples because they concern causal inferences made over long time spans within causal systems so complex and multifaceted as to defeat normative analysis. In conditions of uncertainty, the property transmission hypothesis takes over, and one looks among a bewildering array of possible causes for those that have powers that seem to be capable of transmitting their properties to effect objects. This is no doubt compounded by a failure to compile objective data for covariation analysis: one records instances of adult maladjustment that were accompanied by childhood trauma but overlooks both instances of childhood trauma that were not followed by adult maladjustment and all those people who suffered from neither trauma nor maladjustment. The critical question is, Why were those particular confirming instances selected in the first place? Why not instead take cases of adult maladjustment and look for a diet deficient in selenium or exposure to science fiction novels? When the number of causal candidates is effectively unlimited, the property transmission hypothesis determines which ones are selected for further consideration. Incorrect data sampling for covariation analysis might then take over, but it is property transmission that initiates the journey to the theory by people’s selection of some hypotheses as worthy of consideration and not others.

The history of religion is replete with examples of sacred objects such as relics of the saints or fragments of the True Cross that were supposed to have miraculous powers, usually to cure ills. As an example, the supposed head of John the Baptist was once kept in a cathedral in Amiens, France, and was supposed to have miraculous and protective powers (Ainsworth & Christiansen, 1998). The reasoning was that the holy powers of the original were retained in or transmitted to the relic. A Byzantine icon known as the Hodiqiria was supposed to possess miraculous healing powers because of a belief that it had been painted by St. Luke, who had been a doctor (Cormack, 2000). The supposed powers of the Hodiqiria were believed to be further transmitted to copies of it, and so copies proliferated in other Byzantine communities. Thus, the healing power of St. Luke is transmitted to the icon he supposedly painted, and then the icon transmits the same power to copies of it.

These diverse examples are intended to illustrate the proposition that the property transmission hypothesis influences judgments made under conditions of uncertainty in many domains. Belief in some kinds of paranormal phenomena, religious beliefs, some kinds of scientific thinking, and beliefs about connections between childhood events and adult characteristics may all be influenced to some degree by the fundamental hypothesis that causes tend to transmit their properties to effect objects.

Conclusion

The hypothesis that causes tend to impose their own properties on effect objects encompasses the findings that visual impressions of causality are strongest when the kinematic properties of the effect object after contact match those of the causal object prior to contact; that properties can be transmitted from causes to other objects by unspecified mechanisms not recognized by science; that outcomes that resemble their hypothesized causes are seen as more correlated with those causes than they actually are; that behavior is seen as reflecting the inner personal characteristics thought to cause it more than it actually does; that behavior is seen as more
consistent and predictable than it is to the extent that stable inner causes transmit their properties to behavior; that hypothetical inner acts of will produce actions, the content of which corresponds to the extent of the act of will; and that effect objects (such as holy relics) are believed to have acquired imperceptible properties by transmission of spiritual influence. All of these tendencies can be seen to arise because the property transmission hypothesis is a fundamental domain-general theory of causal influence that tends to pervade domains characterized by uncertainty and that results in relative neglect of causally important factors that do not operate by property transmission.

As I have already said, I do not argue that the property transmission hypothesis supplants or disconfirms other hypotheses and models in the fields to which I have applied it. It is intended to fill significant gaps in those explanatory accounts, to provide a coherent theme running through diverse areas of perception and judgment, and above all to elucidate the true role and importance of the neglected cue of similarity information in many forms of causal perception and inference.

References


Correction to Chida and Hamer (2008)

There is an error in Table 1 of the article “Chronic Psychosocial Factors and Acute Physiological Responses to Laboratory-Induced Stress in Healthy Populations: A Quantitative Review of 30 Years of Investigations,” by Yoichi Chida and Mark Hamer (Psychological Bulletin, 2008, Vol. 134, No. 6, pp. 829–885). On p. 840 the entry for Hill et al. 1987 should be Masters et al. 2004.

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