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Cognitive representations of obligation and prohibition signs when they provide the same amount of semantic information

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The aim of this research was to test whether there is an inherent difficulty in understanding prohibition signs rather than obligation signs. In the experiment conducted, participants decided whether simple car movements presented on a computer screen were allowed or not according to either obligation or prohibition traffic signs. The information provided by obligation and prohibition signs at a T-junction can be understood as messages in the form: A "mandatory left turn" sign indicates that turning right is not allowed, the same as a "no right turn" sign. Both statements mark each of the relevant roads as "*allowed"* and "*not-allowed"* in exactly the same way. However, reasoning studies suggest dramatic differences in behaviour. Previous research showed a general advantage for obligation signs. In this study, the number of alternative roads indicated by these two kinds of traffic sign was controlled using different crossroad junctions. In those particular conditions, our results showed that there is no overall advantage for either obligation or prohibition signs. It depends on the manoeuvre performed by the vehicle. Obligation signs produce faster responses when the manoeuvre is allowed, whereas prohibition signs show faster reaction times when the manoeuvre is not allowed. Those results obtained with diagrammatic information are consistent with some cognitive theories, such as the mental model theory about reasoning with deontic propositions.

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Antecedents

Imagine a car approaching an intersection. There are two possible ways of informing drivers, that they may, for example, turn left but not right, using either an obligation or a prohibition sign. The choice should be determined by the characteristics of the human cognitive system: how we human beings understand a situation and how we infer what is or is not allowed in it. The ideal solution should result in the least effortful and fastest possible driver's response. Although this is a simple example, it helps in presenting more complicated cases where it is necessary to provide information that will lead to traffic decisions.

The psychology of thinking may suggest the best ways of cueing traffic decisions. In our example, using a "mandatory A" sign is equivalent to indicating that taking road B is not allowed, that is, to using the "forbidden B" sign. In this case, prohibition may be considered as some kind of negative counterpart of obligation.

In more complex situations, such as when there are more than two possible routes, the relationship is less simple. Yet, it is generally true that "forbidden B" is equivalent to "mandatory not B". Both statements mark each of the relevant roads as *allowed* and *not-allowed* in exactly the same way. However, research on reasoning suggests that they may result in dramatic differences in behaviour. For a long time, the literature agreed that including negation slows down responses (e.g., Clark and Chase, 1972). This finding has a counterpart in traffic research data. According to MacDonald and Hoffmann (1978), prohibition signs lead to a slower response and a higher error rate than do obligation (affirmative) signs.

However, Wason (1965) reversed classical results by making negation more specific than affirmation (the so-called *contexts of plausible denial*). For example, if all the objects in a row are round except for the sixth, it is very easy to complete the sentence "The sixth object is not round". That is, the disadvantage of negation stems from the fact that it usually provides less specific information than affirmation. If this difference is controlled, negation produces no worse an overall performance and may even have advantages in certain cases. This is known as "*contrast class*" (see Oaskford, 2002). One factor involved in the difficulty of accessing one of its elements is the size of the contrast class. It is easier with small classes such as, for instance, in "the light is not on" (Schroyens, Schaeken, Verschueren and d'Ydewalle, 2000). In reasoning studies with conditionals, other authors (Barrouillet and Lecas, 2002) have demonstrated that reasoning is easier with binary items (If there is a light, it is not on) than with non-binary items (if there is a light, it is not blue). This is

because in the first case there are fewer alternatives to think of: the binary item only has one contrast class (the light is off), whereas the other condition has many (the light is red, white, etc.)

These studies support the semantic account of the effect. The key factor may be the amount of "semantic information" provided by the proposition. A premise contains more semantic information when it rules out more possibilities (e.g., Johnson-Laird and Byrne, 2002). In other words, semantic information refers to how many situations a given sentence rules out. The greater the number of incompatible situations, the more semantic information the sentence provides. According to this view, affirmative propositions are usually easier to process because they typically provide more semantic information, as one can easily observe by comparing the sentences: "my car is white" and "my car is not white". Eliminating this advantage is enough to cancel out – or even invert – the effect.

The purpose of our experiment was to test whether a similar plausible deniability effect occurs in the representation of traffic signs. The design aimed to ensure that prohibition and obligation signs provided the same amount of semantic information. The task consisted of assessing whether the simulated turn of a vehicle was or was not allowed by the traffic signs shown. In the first traffic environment, there was a T- junction and the first scene always showed a car on the lower street. Therefore, there were two possible turns. In this case a "no left turn" sign would be equivalent to a "mandatory right turn" sign. In another traffic environment, there was a 4-way junction and the first scene always showed a car on the lower street. Therefore, there were 4 roads at the intersection and three possible turns. In this case the "no left turn" sign would correspond to the "mandatory right turn or straight ahead" sign. By choosing only signs that were equivalent in the two conditions, it was possible to match exactly the amount of semantic information for both categories of sign (See Figures 1 and 2, in the Method section).

This research tried to ascertain the following: first, what happens in traffic sign comprehension; second, whether there is a real disadvantage of prohibition signs or whether information specificity is the key factor. In our study this question is directly addressed by controlling the amount of information provided by obligation and prohibition signs. However, the goal of this research is more general than just the study of negation. This is merely an example of a much wider range of issues. In general, the psychological study of traffic signs has focused on their conspicuity and neglected the internal representations they produce. However, such representations may be the key factor for driver's subsequent behaviour. A general study of traffic signs and information acquisition from the

standpoint of the psychology of thinking may provide a deeper insight into the way traffic users behave.

Reasoning Processes in Traffic Environments

Research on reasoning has supplied a great deal of knowledge about the representation and processing of information. Traditionally, it has been based on logic, a *normative theory* on how to construct valid arguments that preserve truth values. Research has aimed at finding out how mental operations differ from what is stated by logic. Traffic sign comprehension and information gathering in traffic in general may proceed in a similar way to deductive reasoning.

New research might provide us with a deeper insight into mental processing. Instead of standard logic, which deals with truth values, the starting point in traffic comprehension should be *deontic logic*, which considers *deontic values* such as allowed, not-allowed, compulsory and not compulsory. The relationship between obligation and prohibition signs is an example of this kind of logic. Deontic logic supplements standard propositional or predicate logic with a set of modal operators such as *is allowed* or *is compulsory* and proposes deduction rules for inferring conclusions from premises.

In the field of reasoning, two main kinds of theory have been proposed that account for the way humans carry out standard logical reasoning and explain why they deviate from the normative theory. *Mental logic theories* argue that people have internal *representations* similar to logical deductive rules, which use and transform in order to come to new conclusions (e.g., Braine and O'Brien, 1998; Rips, 1994). In the example used above, drivers would build representations for *A is compulsory* or *B is not allowed* and operate on them by using general knowledge about the relationship between negation and the *is compulsory* and *is allowed* operators, in a similar way to deontic logic inference rules (Cheng and Holyoak, 1985; Rips, 1994). Differences from the normative theory would usually stem from a limitation of memory or attentional resources that prevent people from attaining their maximum logical competence.

On the other hand, according to *mental model theories*, abstract rule-like or proposition-like representations are not generally used in everyday reasoning. Instead, people are thought to rely on representations of specific examples of *states of affairs* compatible with the information they have available (Johnson-Laird, 1983; Johnson-Laird and Byrne, 2002; Polk and Newell, 1995). For example, a "no left turn" sign may get the driver to generate a mental spatial image or similar representation of a left turn, along

with a *feeling* (a symbolic element usually called *mental footnote* in literature about reasoning) that this is not correct. Initially, the image of a right turn would not be present, even if it were possible according to the information provided by the sign. Only later, should it be necessary, would the driver build such a representation. The first kind of image or mental model would be initially *explicit*, whereas the second would be *implicit*. A "turn right" sign would result in a reverse pattern, in which the correct right-turn image was initially explicit and the incorrect left-turn image (or incorrect straight ahead driving image or any other possibility) implicit. This example shows two important features of mental models. First, they may produce radically different representations of the same information. Second, they do not explicitly represent all the possible information but only a subset suggested directly by the stimuli (Goodwin and Johnson-Laird, 2005).

Recently, Bucciarelli and Johnson-Laird (2005) used reasoning tasks to study how people represent sentences such as "workers are obligated/forbidden to go on holiday in August". Their results supported their prediction from the mental model theory: when the word used was "obligated" people represented workers on holiday in August but when the word was "forbidden" they represented workers on holiday not in August. However, they did not use diagrammatic information. Actually, in reasoning studies it is not frequent to use diagrammatic premises (but see, e.g., Bauer and Johnson-Laird, 1993; Moreno-Ríos and García-Madruga, 2002).

The mental model theory provides us with specific predictions about the traffic situations described previously. Those situations consistent with the initial representation derived from the sign will be responded to faster. For example, at a T-junction with an obligatory right-turn sign, people represent the right turn and so, a car in the right location will be evaluated faster than a car in the left location. The opposite will happen in the equivalent scene when a prohibitory left-turn sign is used at the same T-junction. There will be faster responses to the left location, which is consistent with the "initial representation", than to the right. These predictions were confirmed in previous studies (Castro *et al.,* 2008; Vargas *et al.,* 2010). In addition, in those studies, prohibition signs required more time than obligation signs. The cause of this is not completely clear. A possibility is that people think strategically about what is allowed or could be allowed because obligation signs are usually more informative. Drivers keep a goal in mind and look for the way they want to go. The most useful information when driving is where to go rather than where not to go. The prohibition sign tells the driver where not to go. Therefore, it would be

more time-consuming to access the implicit representation from the prohibition sign.

There are at least two different approaches in cognitive psychology that could integrate similar predictions: one from the comprehension field, assuming that prohibition and obligation signs could be interpreted as interconnected, the prohibition being the negation of the obligation. For example, "left is prohibited" could be represented as the negation of the message of an obligation "do not go right" sign. From this view, prohibition signs are more difficult (and therefore time-consuming) than obligation signs. Kaup, Lüdtke, and Zwaan, (2006) stated that the negated proposition is represented first than the affirmative proposition. The negation is more difficult and more time-consuming, because it requires time to make the double representation, and therefore, the prediction is that prohibition signs will be more difficult than obligation signs. Some of the predictions based on Kaup, *et al.,* 2006 were contrasted and confirmed by some of us (see, Vargas *et al.,* 2010).

According to Barsalou (2005), a second general approach could explain how people infer from different situations. The human perceptual system is very frequently exposed to situations such as driving a car after a junction where there is a traffic sign. An abstraction of such situations could enable our conceptual system to predict what will happen, and we can simulate the probable results based on our previous experience. The most frequent result will be the one that is anticipated. We think that similar predictions could be accounted for from this approach. For example, the initial representation in the mental model for an obligation right turn could be coincident with the output of the conceptual system when the scene is perceived.

These different approaches could account for similar predictions (Barsalou, 2005), from the comprehension field (Kaup, *et al.,* 2006) to those of the mental model theory (Bucciarelli and Johnson-Laird, 2005). In previous research we have shown in what conditions it is most difficult to infer whether a location is permitted after a traffic sign (Castro *et al.*, Roca *et al.*, Vargas *et al.*). A challenging question remains as to whetherthe prohibition sign by itself is always more difficult than the obligation sign.

This research aimed to ascertain which of these approaches most accurately describes the mental processing of drivers and pedestrians involved in traffic situations, using the traffic signs' obligated/forbidden information embedded into diagrammatic traffic scenes. Answering these questions may allow us to understand how people represent information from possible diagrammatic traffic situations. This knowledge would be

far-reaching in terms of its usefulness. Not only would it make it possible to decide which signs to use in different situations. It may also lead to proposing re-designed traffic junctions with more powerful signalling systems that convey much more complex information in a way that is easy for road users to understand.

It is important to note that the number of alternative roads was controlled in this study to ensure that there was no probabilistic advantage in choosing prohibition or obligation signs.

METHOD

Participants. A total of 14 participants took part in the study. They were all Psychology students at the University of Granada, Spain. Their ages ranged from 18 to 25. They all had normal or corrected-to-normal vision.

Stimuli. The material used in this experiment consisted of schematic drawings of road traffic scenes where traffic signs – prohibition or obligation – served to direct road users to the road that should be followed (see Figure 1).

Different shapes of junctions and traffic sign stimuli were used in this experiment. With regard to the signs, these are used in traffic environments to provide instructions or regulations that are required by law to be obeyed and which might otherwise be overlooked. Two sorts of regulatory sign were used in the current study:

* *Prohibition signs* indicate a forbidden action (e.g., "no entry") or restriction. They are usually white discs with a red annular border.

* *Obligation signs* indicate a compulsory action (e.g., "turn left"). They are usually blue discs with white symbols.

Different types of regulatory sign were chosen in order to control the amount of information provided by obligation and prohibition signs. The following signs were used (see Figure 1):

- Obligation signs: (at 3-way junctions) turn right, turn left, straight ahead, (at 4-way junctions) straight ahead or turn right, straight ahead or turn left, turn right or left.

- Prohibition signs: (for 3-way and 4-way junctions) no left turn, no right turn, no entry.

In each column of Figure 1 there are obligation and prohibition signs that provide exactly the same information. That is, they mark each road at

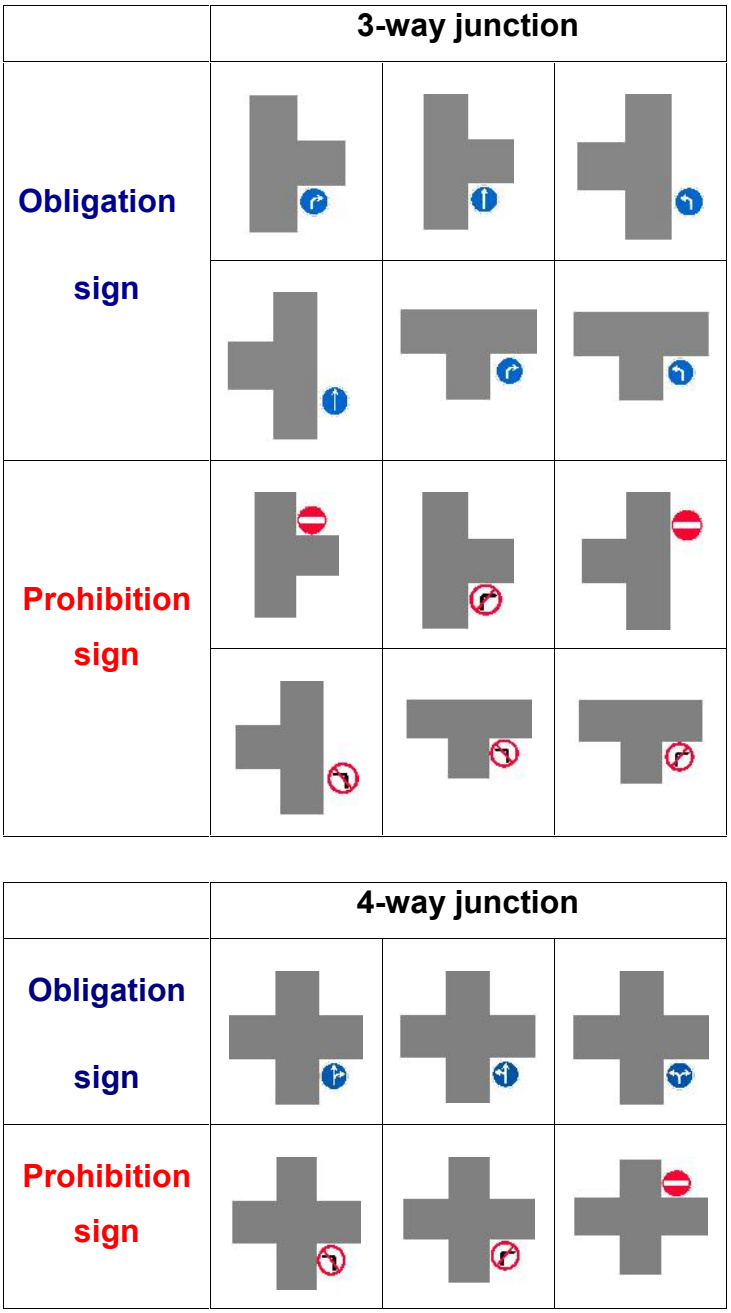

Figure 1. Schematic drawing of the 3-way (above) and 4-way (below) junctions used in this experiment. Traffic regulation signs employed in this experiment. Obligation and prohibition signs provide the same amount of semantic information. All the traffic signs used can also be found in the driving environment and belong to the regulatory sign category from the Highway Code.

the junction as *allowed* or *not-allowed* in the same way. Thus, both kinds of sign are equally specific in each condition.

Note that this involves using different obligation signs in the 3-way junction condition than in the 4-way junction condition in order to make up for the decreased specificity of prohibition signs in the latter condition.

Procedure. Participants were tested individually and were seated in front of a computer screen. The instructions explained that the experiment consisted of evaluating the events shown in two consecutive traffic scenes. The participants were informed that the first scene always showed a car on the lower street with various paths it could follow and a traffic sign with either an obligation or prohibition message; the second scene showed the same car arriving at one of the other two roadways at the T-junction or at one of the three roadways at the 4-way junction.

The '*First Scene*' was shown for 1000 ms. After that, a '*Second Scene*' was displayed for a maximum of 2000 ms or until the participant responded. The presentation of stimuli and the collection of responses were controlled by the E-Prime Version 1.1. Software (Schneider, 2003). Figure 2 shows the temporal course of the screens. The second image immediately followed the first, so the sequence was perceived as a single apparent movement of the car.

The response was to press the "Z key", which was labelled "Allowed", as fast as possible if the manoeuvre was allowed or to press the "M key", which was labelled "Not-Allowed", if the manoeuvre made by the car was not-allowed according to the signs. The response hand was counterbalanced across participants. The programme gave feedback as to whether the response was correct or incorrect.

Participants were therefore carrying out a judgement task. They were requested to respond whether the movement performed by the car was or was not allowed according to the traffic sign located at the scene. The response involved pressing one of two keys *as fast as possible but without making mistakes*.

There were 8 experimental conditions, defined by combining: 2 Junctions (3-way vs. 4-way) X 2 Signs (Prohibition vs. Obligation) X 2 Manoeuvres (Not-allowed vs. Allowed). After reading the instructions, participants performed a block of 48 practice trials (4 trials per experimental condition) followed by 4 blocks of 48 experimental trials each (24 trials per experimental condition). Thus, the total number of experimental trials was 192. The order of stimuli presentation was randomised for each block.

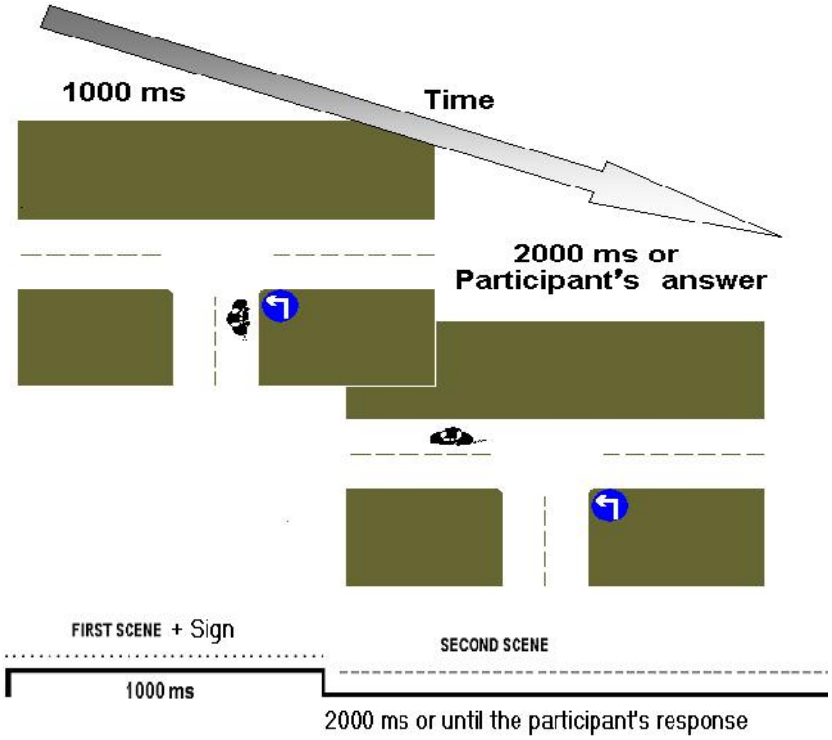

Figure 2. Experimental procedure and scenes sequence. In the example, the car is performing an allowed manoeuvre and the T-junction is signalised with an obligatory turn left sign.

RESULTS

Reaction time (RT) measures for correct responses were submitted to a 2x2x2 repeated measures ANOVA. All ANOVA assumptions were fulfilled. The variables manipulated within participants were the following: Junction: (3-way vs. 4-way) X Sign (Prohibition vs. Obligation) X Manoeuvre (Not-allowed vs. Allowed). As regards accuracy measures, very few errors were made (less than 5%), which means there was not enough observation per condition to carry out an ANOVA. No trade-off was found between Reaction Time and Accuracy measures. The results are shown in Table 1.

The ANOVA revealed a main effect of junction ($F(1,13)=16.36$; $p<.001$; $\eta^2=.56$). The fastest RT was found for the 3-way condition, 597.43 ms; the slowest RT was found for the 4-way condition, 633.37 ms. No differences were found for manoeuvre ($F(1,13)=1.22$; $p>.1$; $\eta^2=.07$) nor,

interestingly, for sign ($F(1,13)=0.7$; $p>0.1$; $\eta^2=.05$). However, the two last factors interacted. The first order interaction between the factors sign and manoeuvre was significant, ($F(1,13)=21.83$; $p<.0001$;$\eta^2=.07$) (see Figure 3). The fastest RT was found for the prohibition sign when the manoeuvre was not allowed, 570.12 ms; and for the obligation sign when the manoeuvre was allowed, 577.99 ms. In addition, the slowest RT was found for the prohibition sign when the manoeuvre was allowed, 670.31 ms, and for the obligation sign when the manoeuvre was not allowed, 643.22 ms.

Table1. Mean Reaction Time (Bold fonts) and Standard Deviation (*Italic fonts*) for the 2x2x2 conditions manipulated: Junction (3-way vs. 4-way) X Sign (Prohibition vs. Obligation) X Manoeuvre (Not-Allowed vs. Allowed).

	3-way Junction		4-way Junction	
	Not-allowed	Allowed	Not-allowed	Allowed
Obligation sign	**605.03**	**522.61**	**639.68**	**604.68**
	195.62	*165.62*	*179.66*	*180.46*
Prohibition sign	**549.48**	**647.78**	**571.98**	**652.92**
	182.42	*170.21*	*163.49*	*176.35*

The main effect of sign was significant both for the not-allowed manoeuvre, ($F(1,13)=6.53$; $p<.024$;$\eta^2=.34$) and for the allowed manoeuvre, ($F(1,13)=20.28$; $p<.0001$;$\eta^2=.61$).

The first-order interaction between sign and junction was also significant, ($F(1,13)=7.23$; $p<.02$;$\eta^2=.36$). The fastest RT was found for the obligation sign with the 3-way junction, 581.81 ms. This RT increased

significantly with the 4-way junction, 639.38 ms. A lower increase in RT was found with prohibition sign and the 3-way junction, 613.06 ms, against the prohibition sign and the 4-way junction, 627.36 ms.

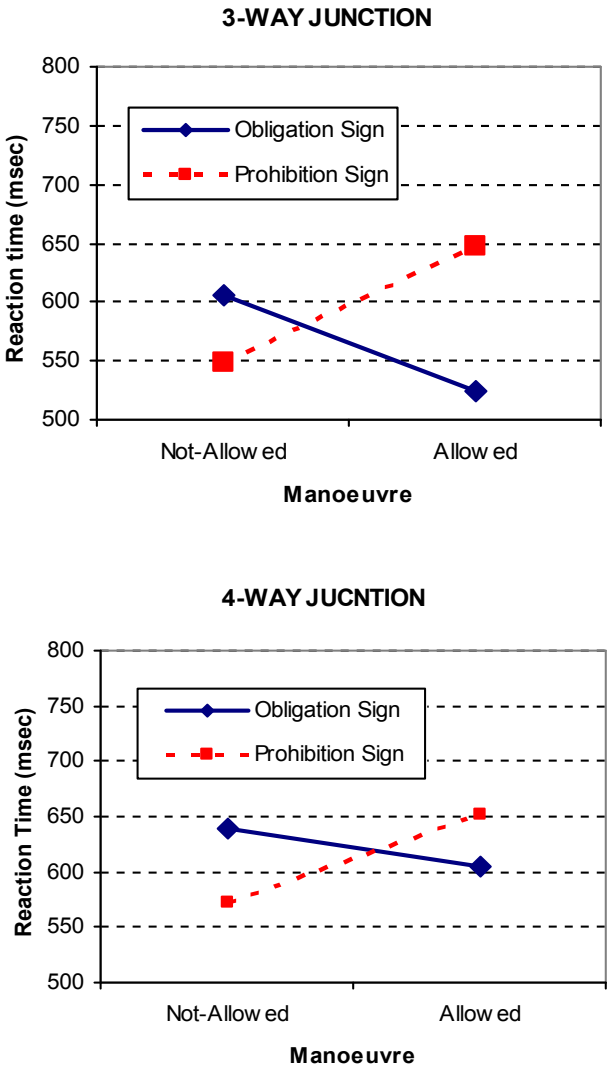

Figure 3. Mean Reaction Time for the 2x2x2 conditions manipulated: Junction (3-way vs. 4-way) X Sign (Prohibition vs. Obligation) X Manoeuvre (Not-Allowed vs. Allowed).

The main effect of sign for the 3-way junction was significant, ($F(1,13)=5.55$; $p<.035$; $\eta^2=.30$).

The planned comparison between obligation and prohibition signs for the 4-way junction was not significant, ($F(1,13)=0.26$; $p<.62$; $\eta^2=.02$).

To sum up the pattern of results, there is a perfect interaction between sign and manoeuvre, with no overall advantage for obligation or prohibition signs. Prohibition signs lead to a better performance when making a *not-allowed* response but *allowed* responses are faster with obligation signs. This pattern of results does not depend on the number of roads at the junction.

DISCUSSION

In the current study, prohibition and obligation signs were equally specific. That is, they always signalled the same number of allowed and not-allowed roads. In this case, responses to the prohibition sign took no longer, on average, than responses to the obligation sign. Such a result supports the hypothesis that it is the specificity of information that plays an important role in explaining the results. The prohibition sign is not inherently worse than the obligation sign. This contradicts a previous assumption (see Macdonald and Hoffmann, 1978) and it appears to be inconsistent, at least partially, with other theoretical interpretations that will be discussed later (e.g. Kaup, *et al.,* 2007).

The results showed no overall advantage of the obligation sign (see Figure 4 below). Instead, performance depended on whether the turn was or was not allowed by the signal, resulting in a perfect interaction between sign category and kind of turn: with the obligation sign, performance was better when reporting that a turn was legal than when declaring a turn not allowed, whereas the opposite was true in the case of the prohibition sign. This pattern is analogous to Wason's results in his research on negation. It strongly favours a semantic account of sign representation, because a) it is difficult to explain an inversion of the effect from a motivational or syntactical standpoint and b) it shows the importance of semantic information (the number of possibilities that particular information rules out). Please note that the number of possibilities ruled out by the prohibition and obligation traffic signs was the same in this study. Therefore, the differences could not have been due to this factor.

The absence of a main effect of type of sign (prohibition vs. obligation) does not imply that they are equivalent in the mind of the driver. The situations presented in Figure 1 are cognitively different. For the

prohibition sign, the assessment of a car on the forbidden road is faster than that of the car on the alternative allowed road. The opposite is true with the obligation sign. The performance depends on the road indicated by the sign and whether the driver may or may not take it. These results can be interpreted by assuming that with an obligation sign the driver represents the allowed road and with a prohibition sign the not-allowed road is represented. The assessment of a situation that matches the representation is faster than that of a situation that does not.

These results fit very well with the mental model theory, which maintains that initially only a part of the information given (known as *premises*) is explicitly represented (Johnson-Laird, 1983, 2006; Johnson-Laird and Byrne, 2002). Other deductive theories in psychology try to explain deontic reasoning with propositional expressions (e.g., Cheng, Holyoak, 1985; Cosmides, 1989; Rips, 1994). In some cases, the propositional expressions (such as "must" or "if something has to be done …") are proposed as the origin of deontic reasoning. In other cases it is the context (such as situations of social exchange) that is presented as the origin of such reasoning. Unfortunately the current description of these theories cannot be adapted to be applied to traffic scenes.

Obligation signs make people represent *right is allowed* or *right is correct* (R-A), and therefore a car in the right position leads to a faster response than a car in another location. Prohibition signs result in a representation of *left is not allowed* (L-NA). In this case, a situation that matches this representation – a car on the left – is assessed faster than a car in another location. Of course, with enough time (and motivation), the complete representation can be obtained in exactly the same set of situations with the two signs in our example. That is, from the information given (*right allowed*) other information can be inferred (*left not allowed*) but this takes longer. The key issue is that time is critical, especially when more complex information is given, driving is subject to time pressure or additional actions are being carried out at the same time. The same logic has been used by Bucciarelli and Johnson-Laird (2005) to explain deontic logic from the mental model theory. They used propositional sentences rather than graphic situations as in the present study. They predicted and confirmed empirically that the understanding of obligation leads people to represent the allowed situation while prohibition is represented by the not-allowed situation.

Some of us have discussed how Kaup *et al's,* (2007) approach could predict behaviour with this kind of traffic sign. The experiential simulation approach (Kaup et *al.'s*, 2007) predicts that the negation is first represented with the content of the "affirmation". Thus, for instance, when processing

an isolated sentence such as "The conductor was not present in the concert hall", the subject first simulates a concert hall with a conductor and then a concert hall without a conductor (Kaup, et al. 2007, pp. 268). Vargas *et al.*'s (2010) results were consistent with the predictions of Kaup *et al's,* (2007) approach about the change in representation of negative (prohibition signs) to affirmative ones (obligation signs) when the exposure time of the signs was manipulated. In all cases, the overall time for the prohibition sign was longer than for the obligation sign and only with a short presentation time (less than 600 ms) were non-permitted situations responded to faster with prohibition signs than obligation signs. It seems that when people have enough time to process the prohibition sign, they change their representation to what is permitted. That is, thinking about where to go instead of where not to go is more adaptive (or effective) while driving. But it could also be because a lot of information provided by the signs was biased in favour of the allowed information. In the current study, longer exposure times were used (1000 ms) and there was no biased information.

From Kaup, *et al's,* (2006) approach, if the prohibition sign were always represented first as "affirmative" and only later as "negative", a longer time would be expected for the prohibition sign than for the obligation sign, because the additional operation of transforming negative into positive is required only with the prohibition sign. In fact, this result was shown in previous studies in all conditions (Castro *et al.*, 2008; Vargas *et al.,* 2010). In the present research, the pattern of results changes. In fact, the general advantage of the obligation sign disappeared when the number of potential allowed and not-allowed manoeuvres per sign was controlled. This situation is not "frequent" in traffic, but it allows us to test "artificially" whether the representations derive automatically from the interpretation of the signs. This does not mean that Kaup is wrong, but it could mean that the processing of prohibition depends on the general proportion of alternatives and other factors, such as the goal direction while driving (see, Roca, Castro, Bueno and Moreno-Ríos, 2012).

Some limitations of the present study come from its experimental nature: no real environment scenes were used, a very small sample of participants (drivers and pedestrians) was tested (but enough to guarantee the required power for the statistical test), manipulation of the exposure time of the signs could lead to different results, etc. However, these findings are interesting because they show that the assumed general advantage for obligation signs over prohibition signs vanished when the number of alternatives given by each piece of information was controlled.

In short, the aim of this paper was to show that some aspects of cognition should be attended to in order to design the best way of presenting

information to a driver. This should be based on how people represent information and the most easily available inferences that can be made with it. Although the experimental situation used here is very simple, the results seem very clear, even in this situation: prohibition takes no longer than obligation, but each is processed in a different way. The data and the theoretical scheme presented provide a promising field of study.

RESUMEN

Representaciones cognitivas de las señales de obligación y prohibición cuando ambas proporcionan la misma cantidad de información semántica. Esta investigación pretende investigar si existe una dificultad inherente en la comprensión de las señales de prohibición respecto a las señales de obligación. En este estudio los participantes decidían si las maniobras realizadas por un vehículo esquemático, presentando en una pantalla de ordenador, estaban permitidas o no de acuerdo con las señales mostradas. Se utilizaron diversas escenas, tales como intersección en T. En estas situaciones, una señal de "obligación a la izquierda" indica también que girar a la derecha no está permitido, es decir, es equivalente a la señalización "no girar a la derecha". Ambas señalizaciones aunque diferentes, determinan igualmente que una de las carreteras está "permitida" y la otra no. Sin embargo, los estudios de razonamiento sugieren diferencias comportamentales ante ambas situaciones. Investigaciones previas mostraron ventaja global para las señales de obligación. En este estudio se controló el número de carreteras alternativas referidas por cada tipo de señal, usando distintos tipos de intersecciones de carreteras. En estas condiciones particulares, los resultados no mostraron ventaja global para las señales de obligación o prohibición, sino que dependió de la maniobra. Las respuestas más rápidas se dieron con maniobra permitida ante señales de obligación y con maniobra no permitida ante señales de prohibición. Estos resultados, usando situaciones esquemáticas, son consistentes con las predicciones de teorías como la de los modelos mentales sobre razonamiento con proposiciones deónticas.

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