Investigating the role of Language in Slot Machine Gambling

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Abstract

A systematic replication of Dixon, Nastally, Jackson and Habib (2009) was carried out to further examine the role of relational framing in attaching meaning to near-win stimuli in a slot machine simulation. The original study found that the verbally reported meaning of near-win stimuli could be altered through a verbal matching-to-sample training procedure. The current study confirmed this finding. Additionally this study had participants play on a simulated slot machine to assess if such relational training also resulted in changes in (non-verbal) response latencies when participants were presented with near-win outcomes during play. A study by Daly et al. (in prep.) had found that near-wins produced response latencies (in terms of initiating a new trial or 'spin') between that of wins and losses during slot machine play; a general finding replicated here also. However, in the current study it was also expected that changes to the meanings of near-wins would influence near-win response latencies. For example, response latencies following near-wins might become more like latencies following losses as a result of prior relational framing of near-win stimuli. The results of this study found a dissociation between verbal and non-verbal responses to near-win stimuli. The verbal training affected verbal responses but did not affect non-verbal responses. Some explanations are postulated for why this happened. These include the possibility that the near-win latency was merely an artefact of the experimental paradigm. Another explanation is that the dissociation between response types occurred because the contexts in the ratings and verbal training tasks were different to the context of the slot machine task.

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Investigating the role of Language in Slot Machine Gambling

Background

Problem gambling behaviour is a major concern for many people as it has a variety of negative consequences ranging from personal health, social, interpersonal and financial problems. As a problem more prevalent than schizophrenia and autism, some gambling researchers like Dixon have called pathological gambling an epidemic that cannot be ignored (Dixon, 2007). Published psychological research on pathological gambling addiction has increased (29 published papers in 1997 to 142 papers in 2006 from PsycINFO with the keyword of “Pathological Gambling”; Dixon, 2007), a trend reflecting the growing interest within various psychological disciplines. One form of gambling of interest to researchers is slot machine gambling because of the high frequency of problems associated with their use (Chóliz, 2010). Chóliz (2010) argues that the onset of pathological gambling appears most rapidly in slot machines (Breen & Zimmerman, 2005) and there is a disproportionate amount of people reporting it as their primary gambling problem (Breen, 2000 as cited in Chóliz, 2010; Jackson et al., 2000 as cited in Chóliz, 2010). Such characteristics allow the development and maintenance of simple repetitive behaviour which lies at the heart of slot machine addiction (Griffiths, 1993).

The slot machine has characteristics analogous to operant chambers which are used to manipulate and shape the behaviour of a subject as a function of reinforcement. Due to these analogous properties, slot machines can potentially be studied using a behavioural analytic framework.

The preponderance of previous psychological research has examined gambling from a social, cultural, clinical or neurological level and has tended to focus primarily on the players themselves: their relationships, their background history or their biological dispositions. An fMRI study by Habib and Dixon (2010) found neurological differences between pathological and non-pathological gamblers. Near-wins experienced in slot machine simulations (i.e. when there was one symbol off a winning combination of slot symbols) activated brain regions associated with wins for pathological gamblers but for non-pathological gamblers they activated regions associated with losses. Another imaging study by Clark, Lawrence, Astley-Jones and Gray (2009) found that near-wins recruited reward related circuitry and this occurred only when the participants had control of their gambling selection. The authors suggested that an illusion of control could be responsible for the participant's increased desire to continue playing after encountering a near-win and that gambling activities probably use a reinforcement learning system handling skill-oriented behaviour.

A recent study by Billeux, Van der Linden, Khazaal, Zullino and Clark (2011) found results in a similar vein but with a cognitive approach. By exploring trait gambling cognitions (e.g. beliefs and skills that relate to winning), they found that skill-oriented cognitions (i.e. illusion of control or acquisition of skill) and not ritual-oriented cognitions (i.e. external factors like context, luck and superstition), predicted subjective desire to continue playing after participants had experienced a near-win on a slot machine task.

In contrast, the bulk of behavioural research has focused on how the player responds to the structural characteristics of the machine. These characteristics include: how the actions needed to play can induce an illusion of control (Chóliz, 2006, as

cited in Chóliz, 2010), how events like a near-win give rise to cognitive biases (Kassinove & Schare, 2001) and their low costs to play (Chóliz, 2010). Further research has examined the relationship between magnitude of reinforcement, response rates and post-reinforcement pauses (Dickerson, Hinchy, England & Fabre, 1992; Delfabbro & Winefield, 1999); immediacy of delivering the rewards and play persistence (Chóliz, 2010) and payback rate and the choice of machines (Haw, 2008).

Close, but no cigar: the event of nearly winning

It is commonly regarded that the money gained from winning in slot machines is the primary reinforcer in these studies. However Griffiths (1999) suggests that the functional consequences of a *near-win* outcome where a player just misses out on a winning combination of slots, is an important factor to consider. Indeed, if we are to consider what happens in slot machine gambling we could realise that every time someone loses they are not experiencing extinction (the absence of reinforcement) but actually punishment since players lose credits from the betting each time. The near-win is objectively a loss and punisher but yet responses to it – neurologically (Clark et al., 2009), verbally (Dixon & Schreiber, 2004) and behaviourally (Daly et al., in prep.) suggest that people are treating it as a unique event that may be seen as like a win (Reid, 1986; Dixon et al., 2009).

The near-win has been found to exhibit various behavioural effects in a number of experiments. For instance, Kassinove and Schare (2001) found that a moderate 30% rate of near-wins delivered during pre-extinction play produced more persistence (i.e. more responses) in playing a machine when participants were in extinction compared to alternative 15% and 45% near-win rates. A similar study by

MacLin, Dixon, Daugherty and Small (2007) presented participants with three machine simulations displayed simultaneously on a computer screen. The pay-out rate was kept constant at 20% across all machines and only the near-win frequency rate was manipulated with 15%, 30% and 45% rates assigned to each machine. Response allocation across the machines did not differ during normal play or extinction until the groups of participants were separated by how long they persisted through the extinction phase. Participants who played over 100 trials during extinction allocated the most responses to the 45% alternative and the least to the 15% alternative. These same participants also had significantly lower total credits than the participants playing less than 100 trials suggesting they were chasing losses or recouping prior wins.

Another measure that suggests near-wins have some properties of wins is response latency. Response latencies are the intervals between the end of one trial (getting the outcome) and the initiation of the next (spinning the reel again). Schreiber and Dixon (2001) found that the event of a win yielded longer response latencies than a loss and that this effect was a practical demonstration of the post-reinforcement pause (PRP) found in studies of simple schedules of reinforcement (Catania, 1992). A previous project in our laboratory (Daly et al., in prep) found that near-wins produced average response latencies that were significantly different from wins and losses: their average length fell between losses and wins. These 'medium' latencies suggested that near-wins were potentially being treated as a conditioned reinforcer, perhaps due to a Pavlovian stimulus generalisation. This near-win PRP effect has been similarly found in rats subjected to a gambling analogue (Peters, Hunt & Harper, 2010) and evidence from this study supported a generalisation explanation in responding to near-wins.

What is clear from past research is that while near-wins are not material reinforcers, and in fact represent material losses, they do not seem to possess the punishing characteristics of a loss. What is also interesting is that the various behavioural effects of near-wins do not affect everyone in the same way. For those susceptible to responding to near-wins as something other than a loss, we do not yet fully understand the mechanisms behind how the near-win could develop this influence. Identifying the crucial variable(s) involved and attempting to manipulate it is a good step towards developing a preventative measure against perceiving and responding to near-wins as a type of reinforcer.

One reasonable argument in explaining the near-win as a reinforcer is proposed in Dixon and Schreiber (2004) where they consider the near-win as a verbal event. Anecdotal evidence suggests that participants in Dixon and Schreiber's study already held beliefs that near-wins were like or predictive of a win even when the study did not purposely manipulate near-wins in that fashion. Similar participant feedback was found in the studies of Daly et al. (in prep.) where people noted the near-win to be a unique type of event and more like a win than a loss. The importance of looking at variables beyond those solely manipulated in the machine (reinforcement schedules, reinforcer density etc.) is also emphasised by Dixon and Schreiber (2004) as some evidence points to the variability seen in gambling behaviour regardless of programmed machine contingencies (Dixon, Hayes & Aban, 2000; Schreiber & Dixon, 2001).

A potential explanation of why a near-win is considered a verbal event is that through experience in other domains some people learn to view near-wins as related to wins in some characteristic way even though they are losses. That is, while nearly correct responses may be predictive of future success in situations involving skill like

nearly hitting the bullseye in archery; this is not true for situations reliant on chance. It is possible that for some people a verbal formulation about near correct responses has formed and generalised inappropriately to a gambling situation from a skill-related situation. This sort of formulation would fall under the illusion of control some players might possess where they believe they are more confident or that they can manipulate chance situations (Moore & Ohtsuka, 1999). Another commonly misapplied rule is that of the Gambler's Fallacy where the player believes or perceives objectively independent gambling outcomes to be dependent upon each other. Thus with such a perspective, certain experienced patterns of probabilistic information come to influence predictions of subsequent events (Barron & Leider, 2009). The fallacy, like illusion of control, is decision-making and responding that has been generalised from skill-based and predictable learning paradigms. Essentially, it would be very useful to understand how such rules could form and be misapplied across various contexts. There have been some recent efforts at looking at how the functions of language and thus rules could be altered in order to influence better behavioural outcomes. An empirical position has been used in the experimental analysis of gambling behaviour called Relational Frame Theory (Hayes, Barnes-Holmes & Roche, 2001).

Relational Frame Theory: A brief introduction

Misapplied verbal rules and their subsequent behaviours may be understood through Relational Frame Theory (Hayes et al., 2001). Relational Frame Theory is a behavioural theory that describes how language is used in a meaningful way. The premise is that meaning comes from our ability to relate two or more

words/events/objects under certain contexts. This act of relating is termed Relational Framing. Applying relational frames learned in one context to other contexts where the frame is inappropriate is hypothesised to underlie many forms of maladaptive behaviour including problem gambling.

Derived Stimulus Relations: A key foundation in Relational Frame Theory

Relational Frame Theory bears a lot of similarities to Stimulus Equivalence (Sidman, 1994) and utilises the phenomena of derived stimulus relations at its theoretical core. A derived stimulus relation is an example of an untrained stimulus relation but is referred to simply as “equivalence” in the stimulus equivalence literature. Stimulus equivalence was formally defined by Sidman (1994) as relations between a set of stimuli such that the untrained relations of reflexivity, symmetry and transitivity are present. During matching-to-sample procedures a subject could be presented with an array of stimuli in the presence of a target stimulus. 'Reflexivity' is when someone picks the stimulus 'A1' in an array of stimuli when presented with A1 – a one-to-one matching of stimuli or identity matching. 'Symmetry' would involve a functional reversal of discriminated stimulus pair relations, for example: Given A1 a subject is reinforced for picking B1, they then subsequently pick A1 when presented B1 in the absence of direct reinforcement. This reverse ‘mirroring’ of relations is symmetry. 'Transitivity' involves combining different related pairs together usually involving a shared proxy stimulus; the simplest involving three stimuli. A1 is paired and related to B1; B1 is also paired with C1. A transitive relation arises when A1 is subsequently related to C1 with no prior relation, training or reinforcement. These

spontaneous, non-trained and non-reinforced relations are referred to as derived stimulus relations in Relational Frame Theory.

The important idea to creating meaning in Relational Frame Theory is not the stimuli per se, but rather the meaning is expressed through their functional relationships, how those functions contact events in the environment and how we respond to these functions. To illustrate this importance of functional relating, try looking up a definition of a word in a dictionary and you will find other words which lead to more words ad infinitum. The dictionary does not contain meaning, only words, but it is our act of relating them together do we find any meaning (Hayes et al., 2001). When verbal behaviour is seen as functional through the act of derived relational responding, it can now become testable through the experimental analysis of behaviour.

Overarching, purely functional operants

Seeing derived stimulus relations as learned behaviour allows to it be investigated through operant learning theory but certain relevant concepts need to be explained before we can understand how language is tackled from within Relational Frame Theory. Firstly, we need to understand the idea of overarching, purely functional operants. While an operant can be conceptualised by its formal topography (the size and form of a learnt response like a single lever press by a rat), a focus on the functions it performs does not necessarily need to be restricted by topographical limits (Skinner, 1953; Hayes et al., 2001). Indeed, even very vaguely defined and broad operants like writing a novel can still be functionally useful. Generalised imitation between an adult and child for instance is a type of overarching, purely functional

operant where the topography varies but the functional rule “copy what I do” remains the same. Language acquirement is based on this generalised imitation process where the focus on the functional aspects (e.g. meaning making and positive interactions) rather than form (e.g. vocal utterances, symbolic text) matters. The various discriminatory contexts and reinforcement to functionally relevant verbal behaviour allows similar non-reinforced response performances to be maintained as well due to the overarching function of “keep communicating” or something similar.

Arbitrarily Applicable Relational Responding

The features of derived stimulus relations and overarching, purely functional operants lay the foundations of verbal behaviour but they do not completely differentiate the processes of language from mere relational responding. What Relational Frame Theory posits is that verbal behaviour is different to other forms of behaviour and achieved when the two features of derived stimulus relations and overarching functional operants participate in Arbitrarily Applicable Relational Responding.

When learning relational responding, most subjects, both human and nonhuman, can be trained to respond to the physical relations between stimuli, whether it is certain heights of blocks (Harmon, Strong and Pasnak, 1982) or matching/non-matching colours (Zentall & Hogan, 1975). What is interesting is that when reinforced to select, say, a physically taller alternative amongst a group of stimuli and then presenting a novel taller stimulus against the previously correct choice, subjects will choose the novel stimulus. The relative rather than absolute physical relations are the factors that are influencing the responding.

However, to respond to just the physical properties (relative or absolute) in a non-arbitrary fashion is insufficient for the behaviour to qualify as derived relational responding since it is completely bound up in the formal properties of the stimuli. Instead, the cues for relating must come from beyond mere physical properties of stimuli, in this case the relational context. This brings relational responding to bear on any stimuli encountered in an appropriate relational context: it has now become arbitrarily applicable and not reliant on stimulus properties to guide responding. An example of arbitrarily applicable relational responding could be to learn the relation “the letter x is greater than letter y” and respond accordingly to the question “which is greater, x or y?” If you were to only attend to the intrinsic features of the stimuli (physical qualities, their status as English letters), the relation and the responses to the relation could never be learnt as letters do not naturally carry any quantitative value. This type of relating is “arbitrary” because the relational cues in the context can be modified on social whim and “applicable” instead of “applied” as natural language situations can still be partly influenced by non-arbitrary features of the environment. With this view we can gradually get a picture for understanding how language and communication is built up. This perspective reveals why language is so flexible, infinitely generative and essentially how meaning is not primarily tied to any particular stimulus form (the formation of letters, natural categorisation etc.) but by the context which influences the meaning-making.

Relational responding can be likened to the overarching operant of generalised imitation through encountering multiple exemplars across a variety of situational contexts and stimulus control. Relational responding under an overarching operant (like verbal learning/imitation) is refined through a process called “abstraction”. Abstraction is defined as “... discrimination based on a single stimulus property,

independent of other properties, thus, generalisation among all stimuli with that property” (Catania, 1998, p. 378). To gain abstraction of verbal behaviour would typically start with word acquirement to be reinforced across a variety of situations. Take for example how a parent might instruct a child to imitate what they are saying to identify things in their presence and to do this across a wide variety of situations. Looking at and naming objects and vice-versa in a young child directly trains the symmetrical relationship of name to object in two separate, unidirectional ways (i.e. must learn A to B and B to A separately). Eventually the child will emerge with symmetrical responding on their own towards novel stimuli as the learning context contains the necessary trained cues and unidirectional training that allow it to happen (i.e. A to B learnt and then automatically learn B to A).

Building on from this word acquirement as abstraction, an arbitrarily applicable relational response is qualified by one more condition: that the response is relational. The act of naming (A to B and B to A) is influenced by the context which can be seen in rule form as “in this context, A goes with B, then B goes with A.” (Hayes et al., 2001, pg. 27). Eventually the rules learnt are not contacted in the environment or from the trainer but can be completely verbal too, allowing verbal rules to shape, generate and control relational responding. Going back to the relevance this holds for being a functional operant, suppose we have the contextual cue of ‘is greater than’ and the stimuli (letters X and Y) that do not feature any formal properties to reflect any obvious quantitative relation. This situation allows one to relate using cues not related to any of the features held by the related stimuli. Now, say we arbitrarily have X be greater than Y and ask “which is greater, X or Y?” we would have to guess at first and any X response reinforced. When presented with “which is smaller, X or Y?” we can now determine what will happen with the contingencies. At

first guessing will be needed, but sufficient pairing of the history of responding to these related stimuli (termed *relata*) in the presence of “greater than” and similarly to the same *relata* in the presence of “smaller than” allows for them to become a coordinated response: a relation in one direction allows deriving the relation in the other direction. This process of derived relational responding is proposed by Hayes et al. (2001) to be the core idea of a relational frame.

Entailment and transformation, alternatives to the descriptive terms of Stimulus Equivalence

Relational Frame Theory gives alternative generic terms to the ones used in Stimulus Equivalence to better capture what is going on in relational frames. A Relational Frame is dynamic, not static and thus technically considered as a verb. The abstracted stimuli to be related must always take part in an appropriate, historically developed context of relating (termed C_{rel}) which is brought to bear on the situation. Derived relations can happen in two ways: the first of which is Mutual Entailment, which is similar to symmetry. If the first relation is specified, the second is entailed, even if the relationship is not symmetrical, hence the more generic use of entailment. It happens when given a certain context C_{rel} , A is related to B in some way and B is automatically related to A in another way.

The second involves two or more stimulus relations and this is called Combinatorial Entailment. Similar to transitivity, two or more relations between the stimuli are combined together (A is related to B, B is related to C and now A and C are mutually related by their connection to B). However, unlike mutual entailment where the derived relation between A and B is precise, combinatorial entailment may

be less so if we face a situation of A is *different* to B and B is *different* to C. We cannot say anything definitive about A's relation to C except for saying we do not know. Combinatorial entailment is the most basic form of relating that allows differences between relations to be seen. In mutual entailment the relations will always be the same: A is same to B, B is same to A; A is opposite to B, B is opposite to A and so on. At the level of combinatorial entailment, different relations start to emerge: A is *opposite* to B, B is *opposite* to C, C is the *same* to A. These types of entailment help to define the relevant form of a relational frame and allow people to build complex relational networks.

When a related stimulus in a network carries certain psychological effects, a transfer of function may take place where the other stimuli in that network change their function depending on their derived relation. Transfer of function has been seen in various pieces of equivalence research including conditioned reinforcing functions (Hayes, Brownstein, Devany, Kohlenberg & Shelby, 1987), elicited conditioned emotional responses and extinction functions (Dougher, Auguston, Markham, Greenway & Wulfert, 1994). However, the term transformation of stimulus functions is used due to some derived relations not being anything similar to the trained function and thus not actually transferred. A good example is to train the stimulus A which has a conditioned punishing function to be the opposite of stimulus B. The predicted result would be that due to B's opposite relation to A, B now has reinforcing functions. It is indirectly trained but the punishing function of A did not transfer to B, instead B's function transformed in accordance with the derived opposite relation to A. Dymond and Barnes (1995) demonstrated this transformation effect empirically with the relations of more-than/less-than.

With these elements of the relational context (C_{rel}), abstracted stimuli, mutual and combinatorial entailment along with the transformation of stimulus functions, they all make up a relational frame. The frames themselves are not static products but a metaphor for the functions of behavioural response patterns with the specific formal features in those patterns determined by the context. Once an organism can relationally frame, they can start to acquire and develop language. There are many different families of relational frames in terms of the nature of relations amongst the stimuli and a list in the following section explains a few of the most common ones.

A few common types of relational frames

Frames of co-ordination are when the relational responding is the same between related stimuli. It is the relation of identity, naming or sameness and forms the basis for a lot of stimulus equivalence research. Naming or identity matching is the simplest frame of co-ordination as it involves no other features to be disambiguated or appeal to beyond the stimuli themselves in the relation and is the most direct e.g. “This is a bear”. Similarity, another form of co-ordination requires a few more cues and a dimension of relation that can be either purely verbal (“B is similar to C”) or from the environment (“Birds and planes are similar because they can fly”).

Frames of opposition are typically acquired after co-ordination and involve relating stimuli along a dimension of opposites. The related stimuli are organised along a single dimensional continuum in a different direction to each other and to a similar degree. For example, “warm is opposite to cool” and “hot is opposite to cold”. The dimension is usually identified through the frame and with the prior example, that of temperature. Like frames of co-ordination, oppositional frames can use purely

verbal or nonphysical dimensions to relate stimuli like “B is the opposite of C”. The reason why these frames come after co-ordination is usually because by looking at the combinatorial entailment involved, the related stimuli would also include frames of co-ordination e.g. “if tiny is the opposite of huge and huge is the opposite of miniscule then miniscule is *similar* to tiny”.

Frames of distinction are similar to frames of opposition in that there is a specified dimension to relate and respond to stimuli based on their differences to each other but unlike opposition, frames of distinction do not allow a specific response. If I am told “This is not an apple,” I will not know what other object it might be: a fruit, food or other thing.

Other more advanced frames include that of comparison which involves responding to stimuli in a quantitative or qualitative manner along some specified dimension. These comparative relations can be made more specific and the stimuli more defined by the dimension in question, e.g. “A is twice as big as F and F is twice as big as N”. Hierarchical frames allow us to make comparisons between stimuli in a typical form of “A is a member of B”. If responding to B is determined in some way, responding to A may follow in a similar manner e.g. “An ostrich is a bird,” can allow us to respond to ostriches in a similar way to how we response to the class of birds. Further explanation on a variety of relational frame families can be found in Hayes et al. (2001).

In summary, the act of relationally framing stimuli as a process of verbal behaviour is argued by Hayes et al. (2001) to be a novel type of generalised operant. An example of this can be seen during the functional reversibility of mutually entailed stimuli: a conditional and discriminative stimulus established through matching-to-

sample procedures have their functions reverse in derived relations (the conditional stimulus is now the discriminative and vice-versa). Such a change in the behavioural processes of responding to these stimuli are themselves a learnt process, we have learnt to alter the process of learning.

Using Relational Frame Theory to study problem behaviour

Research over the last ten years has examined the validity of the theory and its application to understanding verbal behaviour. An early study by Roche and Barnes (1996) showed that separately tested physical stimuli like short and long lines could have their functions transfer as contextual cues (same, opposite and difference) for categorising human sexual terms. Same and opposite frames involved choosing any of the existing stimuli in a trained relational class e.g. given a contextual cue for same and A is same as B; B is same as C: pick C given A in such a context. On the other hand, frames of difference allowed an option of responding with a question mark “?” as some derived relations would entail no specific response e.g. A is different to B and B is different to C, but the derived combinatorial entailment: A is “?” to C was a valid response.

One of the major areas of research is how Relational Frame Theory can be used to understand and intervene on various types of psychopathology and behavioural problems. Hayes et al. (2001) claim “...that human language and cognition is a direct source of many human psychological problems.” (p. 214). The primary point is that due to the ubiquity of human suffering, statistical models or biological approaches may be insufficient to explain why such psychological problems are so widespread even amongst those not clinically classed. Relational

Frame Theory proposes that the transformational functions in our relational abilities and networks allow for impressive development in our behavioural repertoire but this very same repertoire can go in a negative, rather than positive, direction.

The basic idea is that the bidirectional transformation of functions in human language allows us the capacity to suffer to degrees beyond merely contacting an aversive situation or stimulus. While a nonhuman animal can be reminded of shocks in a chamber if they are present in that same chamber, self-reports of being there would not elicit such reminders of pain. Nor will any trained response of reporting pain (e.g. lever pressing) have any distress involved in the response itself (Hayes et al., 2001). However, when you add in the transforming bidirectional stimulus relationships of human language, we as humans can produce new distress and pain when we give reports of past experienced pain. Verbal constructions of painful things could easily have pain transferred to them from the actual physical experience which in turn can make the verbal stimuli aversive. Disastrous and worrisome futures can be envisioned; past events can be verbally altered or made up altogether to be remembered as worse than they actually were. Verbal self-reports can get distorted and give rise to complex emotions like guilt and shame. Humans who have relatively low contact with direct physical sources of pain and aversion ironically encounter them in abundance in the verbal domain which influence their physiological states and behaviour, something that animals do not readily show (Hayes, et al., 2001). Thus, language is both a vehicle for prosperity and ruin; the ultimate hubris of humanity.

Some specific examples of how bidirectional transformed functions contribute to psychopathology include the long-term ineffectiveness of thought suppression (Wegner, 1994) and how reinstated moods at the time of thought suppression bring back the suppressed target thought (Wenzlaff, Wegner & Klein, 1991). The irony of

such an avoidant coping style is that it can make it all the more likely to contribute to a psychopathological condition later (Rohde, Lewinsohn, Tilson & Seeley, 1990). Content in the relational frame cannot be avoided or erased, but can only be added and become ever more complex and multiply controlled. Simply thinking “don’t feel anxious” is an example of how the stimulus of anxiety still participates in the relational frame and thus, anxiety can now be invoked by such a thought. As relational frames and their stimulus functions are also contextually controlled, this relationship can impact on behaviour. Certain relational frames and networks employed in some contexts may be generalised to be used in other contexts. Some problematic situations can arise from this: stimulus functions which are useful and appropriate under some types of contextual control could become maladaptive when the exact relations are applied in other contexts.

Relational framing and gambling

Relational Frame Theory may be applied to gambling and understanding the near-win effect if it is assumed that players of slot machines, who are susceptible to the effect, are using a learning system and relational frame that is primarily used under skill-based learning paradigms. As humans do not regularly comprehend very random events in a highly analytical or predictive way (e.g. by mathematical description and prediction), the development of our verbal/behavioural repertoires for such contexts instead become intimately linked with relational frames that are more developed and more commonly applied.

We usually end up generalising and substituting in the more established and familiar relational frames (e.g. rules of thumb) and learning histories like those associated with contexts of skill-based learning. A good example is that of practicing

archery, as your skill and accuracy increase so does your scoring towards the maximum 10 points or bull's-eye on a target. There is a continuous relationship between your past history and any current shot at the target to give you feedback on your progress. On the other hand, by applying this same "feedback" learning rule while playing Russian roulette, it will not work as no attempt will make you any better at winning (even if it looks like you may be "getting closer" to the same number you pick every time). The verbal rules and functions that work quite well in situations where we have more direct control become absolutely useless and harmful when applied to many gambling situations. Essentially, there has been a lack of abstraction in dealing with the idea of pure luck and high degrees of randomness as there are so few exemplars to refine and importantly, reinforce our responses. We thus apply the next best thing like our knowledge of repetitive cycles or expected probability which lead to erroneous beliefs like the Gambler's Fallacy. A fair coin for instance landing on heads 5 times in a row may yield a probability of $1/32$ but some may fail to notice that this does not make tails any more likely to happen on the subsequent toss. A constant probability of $1/2$ is always in effect and will be for any subsequent toss, however unlikely it may seem. Such errors of judgement are a by-product of us trying to simplify and condense the otherwise enormous amount of data and calculation needed to get a more definitive description of any one highly random event.

Recent studies have used the ideas of relational frames and established verbal histories to examine whether training new derived relations could help players make better or more appropriate responses to gambling stimuli and contingencies. Zlomke and Dixon (2006) was one of the first studies to use the idea of relational frames (in particular, the training of the contextual cues that control the relating) to train their participants in generating self-rules to influence preference in choosing between

concurrently available slot machines. Participants first played on two concurrently available random-ratio slot machines for 50 trials, one with a blue screen background and the other with a yellow background to assess how many trials were played on each machine. Participants had 100 total credits to bet across the two machines. The random-ratio schedules for both machines were a probability of .5 and wins yielded a net gain of 1 credit while a loss just meant the bet amount (set at 1 credit) was lost. To control for reinforcement density differences, a pilot participant's played trials were recorded and these sequences of events were matched for all the participants. The delivery of reinforcement was thus held constant and occurred regardless of switching. Given the .5 probability of reinforcement, all participants ended with 100 credits after 50 trials. The distribution of trials played on both machines were found to be even.

After playing the slot machines, a computer-based conditional discrimination procedure was introduced where the participants were trained the contextual cues of *lesser than* and *greater than* using the colours blue and yellow, respectively. These colours as trained contextual cues could then perhaps signal that the two slot machines used prior, carried some sort of meaning. In this case, the blue machine is associated with something less - like overall pay-out and the yellow machine would be the opposite.

A matching-to-sample task used graded stimuli like images of currency (American bills), academic grades (A+, B-, F etc.) and finishing places (1st, 3rd, 20th etc.) to be displayed on-screen. When presented with a sample image on top and three other comparison images of the same category beneath, participants were reinforced by gaining points and textual feedback ("good job" and "wrong") for clicking on the correct comparison. What determined a correct response was a coloured rectangle that served as a background to the comparison images: a neutral cue that would gain the

contextual functions of *lesser/greater than*. A blue rectangle would signify a *lesser than* context where any comparison chosen lesser in quantitative value than the sample was reinforced and vice-versa with a yellow rectangle for *greater than*. For example, a *lesser than* trial would have a sample image of a \$5 bill presented, with comparison images of \$1, \$10 and \$20, where selecting the \$1 bill was correct. The key to this training was to implicitly learn the relations between the stimuli and have the contextual cue (blue or yellow) signal the contingencies and control the appropriate responding.

An 18-trial block was done to train the *lesser than* contextual cue first with a criterion of 89% correct (16 trials) followed by another 18-trial block to train the *greater than* contextual cue. This was followed by a mixed 36-trial block that combined the previous two blocks together, presenting the 18 *lesser than* and 18 *greater than* trials in random order again with the same criterion of 89% correct (32 trials). Failure to meet the criterion in these phases resulted in repeating the block until correct. A 54-trial block was then administered which featured 30 trials using 3 sets of the trained stimuli, plus 24 trials with 3 novel sets of stimuli. This was done to test if the contextual cues of blue and yellow could transfer their trained functions of *lesser than* and *greater than* to the novel stimuli. No feedback or reinforcement was given during this phase and an 85% correct criterion (46 trials) was in place, failure of which meant repeating the previous phase before coming back to this one. The participants were then re-exposed to the slot machines just like before with all the same contingencies.

Results found that preference was equal for the slot machines in the first slot machine phase but when they were played again after successful relational training, preference was now higher for the yellow machine. The effects of combinatorial

entailment and the trained functions of *greater than* allowed a machine associated with yellow to also gain the functions of *greater than*. In contrast, the blue machine gained the function of *lesser than*. When it came time to choose again in the second concurrent slot machine phase, the previous relationships between blue and yellow which yielded no difference in preferential responding before had now gained a derived relationship: both machines had now gained a quantitative relationship towards the other via the colours (a frame of opposition). In this case, the *greater than* function on the yellow slot machine may have meant a greater overall pay-out rate to the participants and the opposite was true for choosing the blue machine instead of the yellow one.

The relational frame techniques can also be used to alter the verbal functions of a near-win. Dixon et al., (2009) used a matching-to-sample task to establish relational frames that could alter existing functions of near-win outcomes. Participants were first asked to rate 27 images of slot machine outcomes displayed on a computer (pre-test; 9 variants x 3 outcomes): losses, near-wins and wins on a Likert scale of 1 (is not a win) to 10 (is a win) to get their baseline responses. Near-wins were rated as closer to wins than losses. They then exposed the participants to a training procedure designed to change the meaning of near-wins.

The relational training was done through a matching-to-sample procedure (MTS) with a one-to-many (also known as sample-as-node) training method (Saunders, Saunders, Williams & Spradlin, 1993 for a review). Each of the three trained stimulus sets included an abstract image (the A stimuli), a word (the B stimuli) and an image of a slot machine outcome (the C stimuli). The idea was to pair the verbal or word stimuli (“WIN”, “LOSS” and “ALMOST”), with images of slot

machine outcomes (a win, near-win and loss) through combinatorial entailment and thus alter the meaning of the near-win slot machine outcome.

Training was first conducted in blocks of 18 MTS trials. The display of the MTS task had a single sample image on top with three comparison images below. Participants were required to select the image from these comparison stimuli that they considered went with the sample. If they selected the designated correct stimulus a pleasant chime sounded, incorrect responses were followed by an unpleasant error beep. In the first block of 18 trials the A stimuli served as the sample and the B stimuli served as the comparisons. The designated correct responses were to select B1 (the word WIN) in the presence of A1 image; B2 (the word ALMOST) in the presence of the image A2 and B3 (the word LOSS) in the presence of image A3. Trial blocks continued until the training criterion of 16 correct out of 18 was achieved. In the second set of training blocks the A stimuli again served as the sample but the C stimuli served as the comparison images (that is the one-to-many training method was used). In these trials the designated correct responses were to select C1 (the image of a slot machine win) in the presence of A1; C2 (the image of a slot machine loss) in the presence of A2 and C3 (the image of a slot machine near-win) in the presence of A3. Training blocks continued until the training criterion was met. After this, the next phase was a 36-trial block randomly presenting 18 image-to-text and 18 image-to-outcome trials (basically a mix of the two prior blocks) with a criterion of 32 correct. Note that in this training A1 was trained to be associated with the word WIN and winning slot machine images, A2 was trained to be associated with the word ALMOST but a losing slot machine image and A3 with the word LOSS and a near-win machine outcome. The outcomes were not directly trained with the verbal stimuli.

Participants then completed a symmetry and equivalence phase to assess if they had learnt the symmetrically/mutually entailed relations (sample-comparison: text-image, outcome-image) and the untrained equivalence/combinatorial relations (text-outcome, outcome-text). This was done as a 36-trial block with no audio feedback to assess if participants could achieve these derived combinatorial relations without reinforcement. Lastly, the ratings task (post-test) was done again to assess what changes occurred to the ratings of near-wins.

Ten out of the 16 participants who did well in the symmetry and equivalence phase rated near-wins as more like a loss in the post-test ratings. The remaining 6 participants who did not change their ratings of near-wins also showed poor performance in learning the derived equivalence relations. The study concluded that it could be possible to alter the meaning and functions of a near-win to be more like a loss than the commonly misapplied idea of it being more like a win. If such training could be consistently applied, then perhaps interventions could be developed utilising verbal changes that come to control behavioural responding and negating the reinforcing effects of a near-win.

While the ratings did change, the evidence was not conclusive enough to show whether this effect was driven by the training itself or if it was an artefact of experimental demand. There were many trials to establish the counter-intuitive (or intuitive) verbal association which could give the participants a general idea of the hypothesis. In addition, the ratings themselves do not necessarily mean a change to the actual behaviour, that of actually responding to the near-win when playing on a slot machine. With the findings of Daly et al. (in prep.), the current study extended the methodology of Dixon et al. (2009) to include a behavioural measure – the response latencies that occur after outcomes during slot machine play.

The current study: an intersection of language and behaviour

While Dixon et al. (2009) found an interesting effect of ratings changes when participants learnt counter-intuitive relational frames for near-wins, there was no way to tell whether such a change would be seen in a non-verbal response to a near-win happening on a slot machine. One factor that could explain why the ratings changed was simply due to the demand characteristics that arose from the repetitive experimental trials in the verbal training. To further explore how the verbal change would hold up in more rigorous analyses, this study added the behavioural measure of a response latency used in the experiments of Daly et al. (in prep.).

This study thus replicated the relational frame training used by Dixon et al. (2009) but measured the effect of the training in two behaviours (a verbal one and a non-verbal behavioural response). Likert scale ratings were obtained before and after the relational training of the three different slot machine outcomes to assess their verbal change similar to Dixon et al. (2009). In addition, to assess the behavioural effects of the relational training, participants completed a post-training slot machine task. Of interest in this task were the participants' response latencies after each outcome type, the term response latency is used as a more general substitute term for PRPs as loss/near-win outcomes are not necessarily reinforcing. It was expected that these latencies would match changes in outcome ratings, in particular for the near-win.

Another modification was added to this replication: the verbal training included an extra control or consistent condition where the trained relations between the stimuli were expected to be consistent with participants' verbal histories. This was added to check if the resulting response latencies would be different to the ones produced in the replication or inconsistent verbal training condition.

Method

Participants

Sixty-one introductory psychology students from Victoria University of Wellington participated for course credit. Twenty four participants were in the control group while the two verbal training conditions had eighteen in each. One was excluded because they scored over three on the Progressive Gambling Index (see below).

Ethics

Ethical approval was granted by the School of Psychology Human Ethics Committee. Participants were given an information sheet outlining what was to be done in the study and signed consent forms.

Apparatus and Materials

The Problem Gambling Severity Index or PGSI (Ferris & Wynne, 2001) was a gambling screen completed with pen and paper at the beginning of the experimental session to prevent any problem gamblers from taking part in the slot machine phase. Refer to Appendix I for the gambling screen. The main apparatus was a series of four adjacent identical desktop Dell computers running Windows XP (SP3) operating system. The ratings task, verbal training tasks and slot machine simulation programs

were all programmed in Visual Basic Express 10. All the tasks were displayed in full-screen and centred on 17 inch monitors with 1680 x 1050 screen resolution.

Procedure

At the start of an experimental session participants were told, “You are going to complete a series of computer tasks but before that you must look over the information sheet and sign the consent form.” They were then given the information sheet and consent form to sign and told “that as one of the tasks involves gambling they must fill in a gambling screen” and they were subsequently given the PGSI to complete. The PGSI was scored immediately and any participant scoring more than three was given an alternate task during the slot machine phase of the study. At the end of the session these participants were told they had scored relatively highly on a problem gambling screen and were given information about gambling support services they could use if they wished. After the PGSI was checked the participants were told to “carefully read the instructions of the tasks displayed onscreen and once a task is finished the next task will be given to you.”

Three types of computer tasks were administered: a slot machine outcome rating task, a relational training task and a slot machine task. The tasks and the order of their completion by participants was counterbalanced over conditions, see Table 1 at the end of the Method section. Upon completion of each task, participants were immediately administered the next task by the experimenter. Refer to Appendix II for the experimenter script. The control group participants only completed the ratings task and the slot machine task (counterbalanced for order of presentation). The verbal training participants completed the MTS relational training task and a repeat of the

ratings task. When participants began the ratings task, they were presented with these instructions to read:

You will be presented with several images depicting outcomes on a slot machine. When an image appears on the screen, please indicate how close you feel the outcome is to a win by giving it a rating of 1-10 by clicking on the radio buttons you see below the image, with a 1 indicating that the outcome is not a win and a 10 indicating that the outcome is a win.

After you select your rating, click on the “Record Answer” button to record your response and to advance to the next image. Do you have any questions?

After they read the instructions the participants clicked a button labelled ‘Start Task’ at the bottom of the screen to begin. The screen then displayed a slot machine outcome in the centre with a horizontal series of radio buttons labelled from 1 to 10. The participants then clicked on any of the buttons in the 1-10 scale to indicate whether the outcome displayed resembled a win (1 is “not a win” and 10 “is a win”). A ‘Record Answer’ button appeared below after making a selection to confirm their rating. Clicking the ‘Record Answer’ button presented the next image. There were thirty unique images: ten for each event of loss, near-win and win; these were presented in a random order with no replacement. See *Figure 1* for the rating display. The complete set of 30 images is given in Appendix III.

Figure 1. The ratings task with a winning slot machine outcome displayed. The Record Answer button displays once a radio button has been clicked on.

After the ratings task, participants were exposed to the verbal training task.

The instructions presented onscreen for the task were as follows:

You will be presented with one image at the top of the computer screen with three images beneath it. Your task is to choose one of the three images located at the bottom of the screen by clicking on it with your mouse. At various points you will be given auditory feedback that will vary depending on the accuracy of your performance, and at other times you will receive no feedback. When you do not receive feedback, still continue to respond as you did before and do your best.

After reading through the instructions, participants clicked a button labelled ‘Begin the Task’ to begin the training. The verbal training was conducted as an MTS task with a one-to-many training method. The training procedure and stimulus sets were similar to Dixon et al. (2009) with minor procedural modifications. The training used three stimulus sets of abstract images (known as the A set of stimuli), text (known as the B set of stimuli) and slot machine outcome images (known as the C set of stimuli); refer to Appendix III for the stimulus sets.

Inconsistent verbal training condition

The MTS task presented one image from a stimulus set to serve as the sample with three images from another set to serve as the comparisons. The sample was displayed at the top centre of the screen with the comparisons presented horizontally below it (see *Figure 2*). Participants selected the comparison choice they considered to be correct in the presence of the sample by clicking on them. Designated correct choices gave a pleasant ‘ding’ tone while incorrect choices resulted in an unpleasant error tone.

Figure 2. The verbal training screen during the A-B block of trials. The sample A2 abstract image is displayed with the B set of text stimuli as the comparison choices to be clicked on.

Training was conducted over several blocks of trials. The first block of 18 trials had the A stimuli serve as the sample while the B stimuli served as the comparisons (A-B training). The designated correct responses were to select B1 (the word WIN) in the presence of image A1; B2 (the word ALMOST) in the presence of the image A2 and B3 (the word LOSS) in the presence of image A3. The trial block was repeated one more time if the criterion of 16 correct responses was not met and moved onto the next block afterwards regardless of passing or not.

In the second set of training blocks the A stimuli again served as the sample but the C stimuli served as the comparison images (A-C training). Correct responses were to select C1 in the presence of A1, C2 in the presence of A2 and C3 in the

presence of A3. This block repeated once more if the criterion of 16 was not met and moved onto the next block afterwards regardless of passing or not. Across experimental conditions the C2 and C3 stimuli varied. In the consistent condition the C2 image was a near-win outcome and the C3 image was loss outcome. In the inconsistent condition (replicating Dixon et al., 2009) C2 was the image of a loss outcome and C3 was the image of a near-win outcome. Note that the stimulus relations in the consistent condition are all consistent with how one conventionally relates the meanings of the text to the outcomes. *Figure 3* and *Figure 4* summarise how these verbal training conditions were established.

After this, the next phase was a 36-trial block randomly presenting trials from the previous two blocks (i.e. 18 trials from the A-B block, 18 trials from the A-C block) with a criterion of 32 correct. The trial block repeated one more time if the criterion was not met and moved onto the next block afterwards regardless of passing or not.

Participants then completed a derived relations phase to see if they had learnt the mutually entailed relations (sample-comparison: B-A, C-A relations) and the untrained combinatorial relations (B-C, C-B relations). This was done as a 36-trial block (18 of mutual entailment and 18 of combinatorial entailment) with no audio feedback. A criterion of 32 correct responses in this phase was used to determine whether a participant had acquired the derived relations. The criteria used in the trial blocks (16 and 32) gives a value of 89% correct for both numbers and are similar to the percentages used in other MTS equivalence procedures (89% in Zlomke & Dixon, 2006; 90% in Spencer & Chase, 1996).

Figure 3. The relational frame diagram for the consistent verbal training condition.

The rectangles represent the relational frames to be learnt. The directly trained relations from A to B and A to C (one-to-many procedure) are indicated by the arrows. The other untrained combinations that arise from this like B to A and B to C are presented during the last derived relations phase. The objective to passing in this condition is to acquire the derived relations of relating WIN to the outcome of WIN, ALMOST to the outcome of near-win and LOSS to the outcome of loss.

Figure 4. The relational frame diagram for the inconsistent verbal training condition.

Note that only the outcome images in the frames are swapped for losses and near-wins between the inconsistent and consistent conditions. The objective to passing in this condition is to acquire the derived relations of relating WIN to the outcome of WIN, ALMOST to the outcome of loss and LOSS to the outcome of near-win.

After the verbal training task, participants were then exposed to the slot machine phase of the experiment. Participants read through the instructions displayed onscreen as follows:

This is a slot machine task. You start with \$20. On each spin you can bet from 10c to 30c. When all five pictures match each other you win 50c for every 10c bet (e.g. 10c bet = 50c win, 20c bet = \$1 win etc.).

When the task stops please wait until told what to do next. Any Questions?

Once participants read through the instructions they could begin by pressing the button labelled 'Start the Task' at the bottom of the screen. The playing screen consisted of a grey background, a single row of slot reels with betting radio buttons to select (choice of 10c, 20c and 30c) and a play button directly below it. Text boxes displaying the current balance (starting at \$20.00) and amount bet on the most recent play were displayed above the reels and the amount won on the most recent play was displayed below it. While very unlikely, it was possible for the balance to go into the negative. See *Figure 5* for the playing screen.

Figure 5. The playing screen for the slot machine task. The outcome obtained was a near-win and 20c is selected as the bet for the next spin.

Participants selected a bet and then pressed the play button which deducted the bet amount from the balance box and spun the reels which stopped sequentially from left to right. The betting options, the play button and information boxes disappeared during the reel spin to keep the focus on what symbols would appear. Digital slot tunes also played while spinning and a ringing bell sounded off when a win was delivered (5 matching symbols). A win resulted in giving out 5 times the amount bet so if a bet of 10c was made, 50c was given on a win (a net gain of 40c). Losses and near-wins gave out no credit.

The slot machine was programmed for a set amount of 120 trials. There were 12 wins, 36 near-wins and 72 losses in total. To protect against the rare event that many of the wins and near-wins could be presented too early or too late in the session, the 120 trials were separated into 4 blocks of 30 trials each. Each block had 3 wins, 9 near-wins and 24 losses presented randomly without repeats and were presented seamlessly to the participant. This ensured a more even distribution of events.

After playing the slot machine, participants repeated the ratings task to measure any changes in rating the outcomes. This was counterbalanced with the slot machine task (refer to Table 1 for the task administration). The control group participants on the other hand underwent the same procedure but only completed the ratings task once and the slot machine task, both counterbalanced.

In the verbal training conditions up to two participants completed the experiment at a time while up to four participants completed the experiment at a time in the control condition. The control group sessions lasted no more than 30 minutes while the verbal training group sessions lasted no more than 1 hour. Participants were debriefed once they completed all these tasks.

Table 1

The order of tasks presented to participants in each of the three experimental conditions.

Condition		Tasks completed (from left to right)		
Control (no verbal training)	Ratings	Slot Machine		
	Task*	Task*		
Consistent				
Consistent verbal training	Ratings Task (pre-test)	Verbal Training Task (MTS)	Slot Machine Task*	Ratings Task (post-test)*
Inconsistent				
Inconsistent verbal training	Ratings Task (pre-test)	Verbal Training Task (MTS)	Slot Machine Task*	Ratings Task (post-test)*

Note: * ratings and slot machine tasks are counterbalanced for presentation order. Half of the participants in each condition would be exposed to the opposite order (e.g. the post-test ratings task in the consistent condition would be presented before the slot machine task).

Results

The data were collected from each task and analysed in Microsoft Excel. Analysis was conducted on the ratings data from the pre- and post-test ratings tasks as well as on the response latencies in a number of ways. In addition to analysing mean differences across the conditions, the data for the ratings and latencies were also analysed at the individual level. Changes in participants' betting behaviour were also examined by correlating the amount bet with the current balance on a given trial.

Verbal training task performance

The performance data from the verbal training tasks were checked to see if the participants had acquired the derived relations. A participant was deemed as "passing" the verbal training task if they had met the criterion of 32 correct responses out of 36 in the derived relations phase. Sixteen out of 18 participants in the consistent condition passed while, in contrast, 8 out of 18 participants passed in the inconsistent condition.

Ratings analysis

Analyses were conducted on the ratings data to determine whether changes in ratings of the outcomes from the pre-test to the post-test differed depending on the verbal training conditions. Firstly, mean ratings were calculated for each outcome type: wins, near-wins and losses. The mean ratings for each outcome type were then compared against each other to check if the participants had responded in the expected

pattern, that is, that wins would show the highest mean rating, loss with the lowest mean rating and near-wins with an intermediate mean rating. *Figure 6* shows this expected pattern of responding for both the consistent and inconsistent conditions in the pre- and post-tests. However, the mean rating of near-wins in the inconsistent condition decreased in the post-test from the pre-test (but was still higher than losses) suggesting an effect of the inconsistent verbal task that preceded it.

Figure 6. Mean ratings for the outcomes. The y-axis represents the rating scale: 1 means “not a win”, 10 means “is a win”. Outcome types are shown on the x-axis as numbers of matching symbols: 0 and 2 matching symbols are loss outcomes while 4 are near-wins and 5 are wins. The black bars are the mean ratings from the pre-test while the white bars are the mean ratings from the post-test. The top graph is for the consistent condition and the bottom graph is for the inconsistent condition.

Ratings analysis at the individual level.

Further analyses were conducted to specifically determine whether changes in ratings from pre- to post-test for each outcome type (particularly near-wins), were affected by condition. For all participants in the verbal training conditions, a rating change score was obtained by taking the average rating for each slot machine outcome from the post-test and subtracting from it the average rating for the same outcome type from the pre-test. A change score that was greater than zero indicated that a participant rated that outcome type as more like a win in the post-test compared to rating that same type before in the pre-test. A negative change score indicated that the participant rated that outcome type as less like a win in the post-test compared to rating the same type before in the pre-test. *Figure 7* shows the rating change scores on each outcome type for the participants in the verbal training conditions. Overall, the changes in ratings for the loss and wins outcomes were not very large in either direction. However, the bottom graph which is for the inconsistent condition shows that some participants negatively changed their near-win ratings. Those participants now rated near-wins more like losses in the post-test. This is the only consistent and fairly noticeable change happening in the outcome ratings.

Figure 7. Ratings change for each outcome type from pre- to post-test in the individual verbal training participants. Rating change score is plotted on the y-axis and the x-axis indicates each participant. White and light grey bars are the change scores for the 0 and 2 matching loss outcomes respectively. Dark grey bars are the change scores for near-wins. The top graph presents data for the consistent training condition, and the bottom graph data for the inconsistent training condition.

For participants in the consistent verbal training condition there was no significant change in their average ratings for near-wins, and there was no significant difference in the ratings change scores between those who failed and those who passed that training condition. The eight participants who passed the inconsistent training significantly decreased their ratings of near-wins in the post-test compared to the pre-test. That is, these participants rated the near-win as less like a win than they had prior to the training. Pre-test near-win rating ($M = 7.74$, $SD = .81$); post-test near-win rating ($M = 3.90$, $SD = 3.45$), $t(12) = 2.87$, $p < .01$.

Changes for the majority of participants in this group were large with ratings of around 8 before training that decreased to around 1 in the post-test. Those who did not pass the training showed a small but non-significant decrease in near-win ratings. This difference between near-win change scores for those who passed the inconsistent condition compared to those who failed the condition was significant, $t(16) = 2.20$, $p < .05$.

Building on from the change score analysis, scatter plots were used to show the mean pre- and post-test ratings of near-wins for each participant and then further broken down into passed/failed data points. The plots allow us to not only see which particular participant had negatively changed their near-win rating, but whether that participant had passed the verbal training or not.

The top graph in *Figure 8* shows the data for all participants in the consistent training group. Participant mean ratings for near-wins on the post-test were plotted as a function of the ratings for these outcomes on the pre-test. The data points are evenly scattered about the diagonal reference line “the line of indifference”, showing a lack of a consistent change of ratings in this group. When separating these participants into

passing and failing, the bottom graph in *Figure 8* shows that the participants who failed were not different to those who passed.

The inconsistent group display a more varied pattern of rating changes as eight participants decreased their near-win ratings in the post-test, six of them decreasing dramatically (top graph in *Figure 9*). When breaking this data down by passing or failing the inconsistent verbal training, an even more compelling image (bottom graph in *Figure 9*) illustrates how the training influenced the change. All the failed participants except for one showed no major changes to their ratings of near-wins from pre- to post-test as the crosses are scattered on or very close to the line of indifference. These data support the idea that passing the inconsistent training was uniquely associated with a change in ratings of near-win outcomes, and are consistent with the ratings change results reported by Dixon et al. (2009).

Figure 8. Mean post-test near-win ratings plotted against pre-test near-win ratings for each individual in the consistent training group. Each datum point is one participant's mean rating for the near-win outcomes in the pre- and post-tests. The position of the point along the x-axis is their mean pre-test ratings of near-wins and the position along the y-axis is the post-test mean rating. A datum point under the line of indifference indicates that that individual decreased their rating from pre- to post-test and a point over it indicates that an individual had increased their rating. The line of indifference is the function $x = y$, therefore points on the line indicate no change from pre- to post-test. The top graph displays all the data points, the bottom graph separates them by those who passed the consistent verbal training (triangles) and those who failed (crosses).

Figure 9. Mean post-test near-win ratings plotted against pre-test near-win ratings for each individual in the inconsistent training group. Each datum point is one participant's mean rating for the near-win outcomes in the pre- and post-tests. The position of the point along the x-axis is their mean pre-test ratings of near-wins and the position along the y-axis is the post-test mean rating. A datum point under the line of indifference indicates that that individual decreased their rating from pre- to post-test and a point over it indicates that an individual had increased their rating. The line of indifference is the function $x = y$, therefore points on the line indicate no change from pre- to post-test. The top graph displays all the data points, the bottom graph separates them by those who passed the inconsistent verbal training (triangles) and those who failed (crosses).

Response latency analysis

To assess whether the influence of training had transferred to non-verbal behaviour, response latencies following each outcome type in the slot machine task were examined. Medians were taken for the outcome response latencies from the individual participants in each condition and used in the individual data analyses. For each participant, the median response latency was calculated for each outcome type. Subsequent analyses used these medians. Note that both types of clear loss (0 and 2 matching symbols) were collapsed into a single type of loss “Loss-All” for the analyses unless otherwise stated. Table 2 shows the means of these medians for condition and outcome type.

Table 2

Means of median response latencies after each outcome type in each condition

	Wins	Near-wins	Losses
Control group	2641	1622	1461
Consistent group	2914	1667	1482
Inconsistent group	2775	1706	1472

Note: Latencies are in milliseconds.

A mixed 3x3 ANOVA with one between-subjects factor (condition: control, consistent, inconsistent) and one within-subjects factor (outcome type: win, near-win and loss) was calculated on the medians for each outcome type. There was a significant main effect of outcome type $F(2, 114) = 224.32, p < .01$. The main effect

of condition was non-significant $F(2, 57) = 0.37, p > .05, ns$ and the interaction was also non-significant $F(4, 114) = 0.82, p > .05, ns$.

Response latency analysis at the individual level.

Analyses for the individual participants' response latencies were also conducted in order to assess the consistency in the reported mean difference by outcome. *Figure 10* shows the scatter plots for the verbal training conditions and illustrate how robust and consistent the response latencies were after each outcome type. Participants in both verbal training conditions displayed the same pattern of response latencies, a majority of them had near-win latencies longer than losses and all of them had near-win latencies shorter than wins.

- ◆ Consistent group: Near-wins vs. Losses (All)
- △ Inconsistent group: Near-wins vs. Losses (All)
- Linear (Line of indifference)

- ◆ Consistent group: Near-wins vs. Wins
- △ Inconsistent group: Near-wins vs. Wins
- Linear (Line of indifference)

Figure 10. Median response latencies after near-wins plotted against loss and win latencies for each individual in the consistent and inconsistent training groups. The individual participants in the consistent group are the black diamonds while the individual participants in the inconsistent group are the white triangles. Points over the line of indifference mean that the near-win latencies are longer than loss/win latencies and shorter than these latencies if below the line. The top graph is for the comparison between near-win and loss latencies, the bottom graph for near-win and win latencies.

Time course analysis

The analysis above showed no significant effect of condition on response latency, where response latency was represented by the session median. However, the possibility remains that the conditions affected latencies early in the slot machine task, which were closer in time to the training task. For this reason, latencies were analysed as a function of trials into the task. These data are presented in *Figure 11*.

Figure 11. The median response latencies plotted by successive outcomes of each type.

The y-axis measures the response latency in seconds. The x-axis plots outcome number as a proportion of the total number of outcomes of that type. For example the median response latency of the 6th win out of the 12 wins can be found at 0.5 on the x-axis. Similarly the median of the 36th loss out of the 72 losses can be found corresponding to 0.5 on the x-axis. The wins are plotted as circles, near-wins are the diamonds and losses are the crosses. The top graph is for the control condition, the middle graph is for the consistent condition and the bottom graph is for the inconsistent condition.

Control group counterbalance analysis

To check whether there were any presentation order effects from the ratings and slot machine tasks, two-tailed t-tests were calculated on the mean ratings and median latencies from the control group who completed the ratings and slot machine tasks, but did not complete a relational training task. There were no significant differences between the 12 control participants who completed the ratings task before the slot machine and the other 12 who completed the ratings task second in terms of rating the near-wins and wins. However, significant differences were found for the ratings of loss with no symbols matching ($t(22) = 2.29, p < .05$) and loss with 2 symbols matching ($t(22) = 2.42, p < .05$). For participants who did the ratings first, their loss ratings (both 0 & 2 matching symbols, $M_s = 1.77$ & 3.08 , $SD_s = 1.01$ & 1.25 respectively) were higher on average than those who did it second (0 & 2 symbols matching, $M_s = 1.08$ & 1.93 , $SD_s = .23$ & 1.07 respectively). There were no order effects found for the outcome latencies.

Betting behaviour analysis

As previously described, the slot machine latencies were examined to see if the verbal training influenced non-verbal behaviour. The previous analyses showed no effect of verbal training on latency. Another non-verbal behaviour recorded was amount bet. Exploratory investigation of this behaviour indicated that condition did not affect total bets. However, bet amounts were influenced by balances and this relationship was related to condition. Table 3 shows negative correlations in all conditions, but these were only significant for participants in the inconsistent

condition. Participants in this condition bet higher amounts as their balance declined. Note that balance declined as the slot machine task progressed. When the inconsistent training group was divided into participants who passed and participants who failed, correlations between amount bet and balance was stronger for the passing sub-group compared to the failing group, but both were non-significant due to low sample sizes.

Table 3

Correlations between balance and betting amounts for each condition

Balance (by group)	n	Bet Amount
Control group	24	-.17
Consistent group	18	-.19
Inconsistent group	18	-.40*
Inconsistent passed	8	-.49
Inconsistent failed	10	-.34

Note: * $p < .05$.

Discussion

The current study replicated and extended the relational frame verbal training method used in Dixon et al. (2009). Using relational MTS training, Dixon et al. (2009) had participants change their ratings of near-wins from being like a win to being more like a loss. In addition to replicating the verbal training procedure, the experiment in this study used the phenomena of post-reinforcement pauses to determine whether the verbal changes would induce similar changes in near-win response latencies. It was

found in a previous set of experiments from Daly et al. (in prep.) that near-wins produced response latencies in between the shorter loss latencies and the longer win latencies. Building on from this evidence, it was expected that if verbal responding to near-wins changed to be like losses with the MTS training then perhaps near-win latencies would lower to be the same as losses.

Summary of findings

The ratings results from the verbal training were similar to those found by Dixon et al. (2009). Those who successfully passed the inconsistent training rated near-wins to be less like a win from pre-test to post-test ratings. The significant effect of the training condition on the verbal rating task was observed in almost all individuals who successfully completed the training task. Those in the consistent training group and those who failed to pass the inconsistent training showed no significant changes from pre- to post-test ratings for near-win outcomes. The ratings for the other outcome types (losses and wins) did not change for either of the verbal training conditions.

A latency analysis of user-initiated trials in the slot machine task revealed a significant main effect of outcome type (loss, near-win and win) on the response latencies. Loss latencies were the shortest, wins the longest and near-wins in between. These effects were observed in almost all individuals and confirmed the near-win effect on response latencies as found by Daly et al. (in prep.) However there was no effect of the training condition on these latencies. For example, although an individual could display a change in verbal rating following successful inconsistent training such

that they rated near-wins more like losses, their response latencies following near-win trials in the slot machine task did not become more like those following loss trials.

The time course analysis of the latencies showed that for all outcome types the response latencies were highest when they were first encountered but any more subsequent ones had their duration decrease and stabilise. This drop happened for all outcome types within approximately three encounters of that outcome type suggesting very quick habituation. Despite all outcomes dropping in latency over time, on average they still kept their order with wins being the longest followed by near-wins and then losses providing further evidence to how robust the near-win effect is.

Explanations for the dissociation of ratings and latencies

The findings suggest dissociation between verbal and non-verbal responses to near-win stimuli. The verbal responses were influenced by the verbal training while the non-verbal responses were not affected. A few explanations can be postulated for why this happened.

The ratings change could simply be an artefact produced by the verbal training paradigm. The time between the ratings pre-test and post-tests were short, done in the same session and the many repetitions of rating the outcomes in addition to the same outcome images used in both rating and verbal training tasks could have alerted the participants to the experimental hypothesis. Although response latencies typically differ depending on outcome type, people are not aware of these differences so this measure would unlikely be controlled by experimental demand. Experimental demand is also a less likely explanation than other explanations because those who did not

acquire the inconsistent derived relations are still subject to the same exposure of multiple tasks and outcome stimuli but their ratings of near-wins did not change. This suggests that the effect of the verbal change was due to the acquisition of the relational frames.

One other explanation for the dissociation of effects of verbal training relates to the contextual control applied in the tasks. When rating the outcomes in the ratings task, the participants rated static pictures of the outcomes in terms of their resemblance to a win. In the verbal training tasks, static images were used again. The contexts for these two tasks were the same. In contrast, the slot machine task presented the images in another context. The outcomes presented in the slot machine were dynamic (due to the spinning and stopping of the symbols) as opposed to static and thus elicited very different types of responding. For instance, it is very easy to rate a static near-win as like a loss once it has been verbally associated with a loss but when presenting it on a slot machine a near-win could be four symbols stopped with the last still spinning giving the near-win a status between that of loss and “becoming a win”. Since the contexts differed in terms of outcome presentation, the functions and relations of the stimuli transformed and thus any verbal rules associated with static outcomes become irrelevant in the slot machine task. There usually is generalisation across similar contexts which allows for the growth of relational networks but it is limited in how far this can go.

Previous evidence to support this explanation stem from the literature demonstrating that trained and derived stimulus relations depended on contextual control. For example Wulfert and Hayes (1988) trained participants so that in the presence of a green cue, the stimuli A1, B1, C1 and D1 formed an equivalence class but in the presence of a red cue A1, B1, C2, and D2 formed an equivalence class. Thus,

C1 and D1 participated only in the equivalence class and used as appropriate response choices when the context of green was presented. Further emergent derived relations and transformations of stimulus functions could be controlled as well (Zlomke & Dixon 2006; Barnes & Roche, 1996, Roche, Barnes-Holmes, Smeets, Barnes-Holmes & McGeady, 2000).

Challies (2005) found differential effects in participants' responding to a misinformation memory task depending on the context they established equivalence classes in. A memory of a pictorial image was altered through learning a pictorial equivalence set (i.e. memory hindered by misinformation from the pictorial set) but not by learning an equivalence set based on a textual description of the pictorial image. In this case, similar contexts (image paired with image) interfered with remembering something rather than aiding it and dissimilar contexts (image paired with text) did not interfere with memory of the image.

There is one piece of evidence that stands against this contextual control explanation. Data from the inconsistent condition differed from data obtained from the other conditions in the slot machine task on one behavioural measure – the relation between bet amount and current balance. The inconsistent group participants' data showed a significant negative correlation between bet amount and credit balance. That is, they bet higher the less credit that was in their current balance. However, it may be that the result was a Type I error. Further replication of the slot machine task and analysis of the betting behaviour will be needed to evaluate the validity of the contextual control explanation.

A third explanation of the dissociation between ratings and response latency has to do with the latency data. The latency results add to the number of studies

showing a unique response effect to near-wins. In this study the near-win effect was particularly consistent across participants. This latency difference has been interpreted as an increase in latency to near-wins compared to losses as it has conditioned to be like a win. Another way of interpreting the near-win effect could be that the shorter latencies after losses were the result of loss outcomes being predictable earlier during the outcome delivery (i.e. reel spinning). That is, if the second symbol does not match the first symbol you know it is a loss. Thus the participants can start planning their next bet even though they cannot act on the plan until the end of the spinning animation. Based on this idea, the larger latency for wins is indeed a PRP, but the intermediate latencies after near-wins are longer than losses only because participants have not had the same amount of time to plan their response. In this scenario, the near-win latency is not due to the near-win being perceived as close to a win but as a product of time required to plan the next move after receiving it.

These above two explanations could be investigated in future research. The first suggestion could be to have the symbols spin but all stop at the same time. If the near-win effect is observed then the different latencies are not an experimental artefact and thus the dissociation between the ratings changed by the verbal training and response latencies still need explanation. If the near-win effect does not occur then the result would bring into question the whole phenomena of the near-win.

The second suggestion is to determine whether the incongruent contextual control across the tasks is responsible for the dissociation. The ratings, verbal training and slot machine tasks can all present dynamic outcome stimuli (spinning and sequential stopping reels) to increase the similarities of context between them. An alternative and perhaps more convincing demonstration of the incongruent context effect would be to systematically vary contextual similarity. The procedure could have

conditions where all tasks have the same context (all dynamic or all static) or having one task differ (either replicating the contexts applied here; ratings as static with verbal training and slot machine dynamic along with the reverse combination; or having the slot machine use static and the other tasks are dynamic and so forth). Such a modification can also check if the ratings could still change if there were differences in context between the ratings task and the verbal training.

Implications for the near-win

The findings from this study support the near-win having an effect on non-verbal behaviour as displayed in the previous behavioural research (Kassinove & Schare, 2001; MacLin et al., 2007) and in particular confirming the findings of Daly et al. (in prep.). The results are even more compelling in this study in that it demonstrated a robust and consistent effect of intermediate near-win latencies for nearly every participant in each condition. However, without corresponding changes of near-win latencies to ratings changes the exact mechanism behind what governs the near-win effect is still uncertain, and as noted above the latency may in fact be an artefact.

Implications for Relational Frame Theory

The data supports the relational training method used in Dixon et al. (2009) and this study extended it further by adding in a consistent training condition which revealed the differential responding between verbal training conditions. There was no such control in the Dixon et al. (2009) study.

An alternative to testing the relational framing procedure in more depth includes relating near-wins to wins instead. As there is a large gap in duration between near-win and win latencies, could it be possible that if this verbal relation were to be established, near-win latencies would increase?

An issue resulting from the verbal training tasks was that many of the participants failed the inconsistent training (ten had failed to reach the criterion for derived relations). This is not too surprising if we consider that the training involved relating the stimuli in a way that was incongruous to the assumed verbal histories of the participants. On the other hand, the consistent condition was compatible with existing relational frames so the stimuli could be easily integrated into existing relational networks.

Previous evidence (Watt, Keenan, Barnes & Cairns, 1991) had found that verbal histories and social contextual knowledge could interfere with the emergence of derived relations. Indeed, participants made more errors and took longer to respond in the inconsistent training compared to those who completed the consistent training. However, the difficulty in acquiring the inconsistent relation had some benefit. This group ended up with two sets of people, both had experienced the stimuli in the same amount of time. The effect of verbal training on ratings for those who passed the inconsistent training provides convincing support for the acquisition of the relational frame. Regarding the implications for Relational Frame Theory in general, the results and the dissociation found pose a new question for future research. Studies that have used the Relational Frame Theory perspective to guide their experimental methodology have tended to train verbal relations and then test the effects in an exclusively verbal way (e.g. train verbal relations and then record the resulting verbal responses). The dissociation between the verbal and non-verbal responses found in

this study suggest that further research using the Relational Frame Theory approach should also assess how the verbal training may influence a variety of non-verbal responses.

The broader implications

Gambling is a big problem and near-wins have been identified as a factor that can contribute to the development of gambling pathology (Reid, 1986; Griffiths, 1999). The implications from this study suggest however, that educating people so they can verbally describe near-wins as being like losses is not necessarily going to change their responding to near-wins as they play on the slot machine. When we take the contextual control explanation into account, interventions outside the context of slot machine playing would be unsuccessful due to incongruous contexts of intervention and the actual responding to slot machine outcomes. Instead we should be developing ways to intervene on the responses to slot machine outcomes in a context that is very similar to the contingencies experienced when playing. However, this is not to say that verbal manipulations are completely ineffective. Raising the awareness that near-wins are actually losses can still lead to rule governed behaviour that promotes avoiding slot machines altogether, therefore negating any problems associated with responding to near-win outcomes.

Suggestions for future studies

Future studies designed to assess the various explanations for the dissociation have been described above. In a broader view, future studies could use an additional

behavioural measure to investigate if other behavioural responses are more sensitive to changes in verbal relations. For instance there is evidence of increased matching sensitivity in concurrently presented slot machines that have near-wins present in them as opposed to not having any present (Daly et al., in prep.). Perhaps response allocation and matching sensitivity on two concurrent machines may decrease with this inconsistent training procedure. Analysing non-verbal responses through the matching sensitivity measure should avoid the issue of whether the near-win latency will get faster, as loss latencies already appear to be at floor level for response speed. There is also evidence for the effect of near-wins on persistence (Kassinove & Schare, 2001) and response allocation during extinction (MacLin, et al., 2007) as discussed in the introduction. The inconsistent training may be more effective at discouraging further play rather than trying to affect responding to near-wins by themselves.

Lastly, a long-term verbal training procedure broken into multiple experimental sessions could be used to establish whether verbal changes in the meanings of near-wins were long-lasting. The utility of the inconsistent training task would be severely compromised if the training effects only lasted as long as the experimental session and dissipated soon after.

Overall summary and concluding remarks

Near-wins are an interesting type of event that has unique effects across various domains. The mechanism underlying this is still yet to be determined and therefore, ways of influencing the response to near-win stimuli is unclear. Dixon et al. (2009) found that applying relational frame training techniques through MTS could change the ratings of near-win outcome images to be more like a loss than a win and

suggests that relational framing could be examined for their influence on actual playing behaviour.

The current study attempted to replicate and combine this verbal training procedure with the near-win response latency evidence found by Daly et al. (in prep). While ratings changed confirming the findings of Dixon et al. (2009), the training had no effect in changing the response latencies when playing on the slot machine.

It was concluded that the lack of an interaction between verbal training condition and response latency could be explained by the differing contexts used in the ratings and verbal training tasks compared to the slot machine. Controlling for context across the conditions for all tasks is a viable step in future studies to further evaluating the application of relational frame training techniques for intervening on the near-win effect.

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Appendix I: Problem Gambling Severity Index

Thinking about the last 12 months....

1. Have you bet more than you could really afford to lose?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

2. Have you needed to gamble with larger amounts of money to get the same feeling of excitement?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

3. When you gambled, did you go back another day to try to win back the money you lost?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

4. Have you borrowed money or sold anything to get money to gamble?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

5. Have you felt that you might have a problem with gambling?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

6. Has gambling caused you any health problems, including stress or anxiety?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

7. Have people criticized your betting or told you that you had a gambling problem, regardless of whether or not you thought it was true?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

8. Has your gambling caused any financial problems for you or your household?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

9. Have you felt guilty about the way you gamble or what happens when you gamble?

- a.** Never **b.** Sometimes **c.** Most of the time **d.** Almost always

Appendix II: Experimenter Script

“Hi I am _____ and today you will be completing a series of computer tasks but before we begin can you please look at these information sheets and sign the consent form?”

Hand participants the information sheet with consent form, collect them back once signed.

“Here’s another sheet for you to fill out, this must be completed before we can start. These are for gambling activities you would typically play at the casino, lotto does not count.”

Hand them the SOGs sheet.

“Okay so in front of you is the instruction screen for the first task, each task will have an instruction screen like the one shown so the procedure is straightforward. Once you have completed a task you will be prompted and at that point I will come and give you the next task. If there are any questions or technical difficulties experienced during the session do not hesitate to ask me for assistance. Please read through the instructions for this task now.”

Wait for them to finish reading.

“Are there any questions?” Answer any questions.

“You may now begin the task.”

Administer all the relevant tasks. Once all tasks are completed begin debriefing.

“Okay all the tasks are now completed, here is the debriefing sheet.”

Debrief by explaining the basics of the experiment, ask the participants what they thought of the session and answer any questions.

“Thank you for participating in this study today, I have now given you your IPRP credit.”

Make sure all participants have been credit and reset all tasks for next session.

Appendix III: The training stimuli and slot machine outcome images

The abstract images used in the A set of verbal training stimuli: A1, A2 and A3 from left to right.

The text stimuli used in the B set of verbal training stimuli: B1, B2 and B3 from left to right.

The win (top image), near-win (middle) and loss (bottom) slot machine outcomes used in the C set of verbal training stimuli.

All 30 outcome stimuli used in the rating task, 10 variants of each of the three outcomes.