Spring 2017

# GAMBLING RESEARCH REVEALS

ALBERTA GAMBLING RESEARCH INSTITUTE

## Pigeons, People and the Near-Miss Effect: An Interview with Jeffrey Pisklak

**Jeffrey Pisklak is a Ph.D. Student in Psychology at the University of Alberta. He received an Institute graduate scholarship in 2016-17 to investigate the role of near-miss events on gambling behaviour.**

### What's your academic background and how did you find your way into gambling-related research?

My past research has focused primarily on comparative studies of risky choice behaviour in pigeons and humans. As part of my Master's thesis I expanded on earlier comparative work I'd done examining the influence of extreme-outcomes inside a context of risky choice. A basic reality of working within the field of risky-choice is that you can't help but be confronted by the proverbial "elephant in the room" that is gambling. There is a natural extension from one to the other and I'd say that it was clearly one of the catalysts that spurred me on to gambling research. Another was the fact that I have a rather strong affinity to what

The primary aim of the Alberta Gambling Research Institute, a consortium of the Universities of Alberta, Calgary, and Lethbridge, is to support academic research related to gambling.

**MISSION**

To facilitate evidence-based broad research that informs gambling public policy and educates Albertans and the wider audience about the effects of gambling.

is known as "operant learning" which, in its simplest form, is just learning that is shaped and maintained by environmental consequences. It's difficult to think of another field of research that has such a strong symbiotic fit with the principles of operant learning as gambling research does.

## Your research interests relate to the "near-miss effect"… could you tell us more about this phenomenon?

The "near-miss effect" refers to the idea that near-misses (also called near-hits or near-wins) prolong gambling. A near-miss is just a loss outcome that resembles a winning outcome in some way. The prototypical example is seen on a three-reel slot machine. If a win consists of seeing three cherries, a near-miss would be two cherries and a lemon. When you obtain an outcome like that, there is a sense that you have "nearly" won, but of course this is a complete fallacy. The random element of casino games ensures that a near-miss is no "nearer" to a win than any other type of miss you might obtain.

Strictly speaking, there are lots of different types of effects near-misses have been said to have on gamblers (e.g., increased skin conductance, increased frustration, localized brain activity, etc.); however, when the near-miss effect is explicitly being referred to, researchers typically mean the ability of near-misses to prolong gambling.

## You indicate that the reinforcing function of the near-miss effect has not been firmly supported in scientific literature. Can you provide additional background about this? How does your research fit into what is known?

A critical concept within the field of operant learning is reinforcement. A reinforcer is just a consequence of behaviour that increases or maintains the probability of that behaviour occurring again in the future. For instance, anyone who has rewarded their dog with treats for performing tricks has seen reinforcement in action first hand. When we talk about near-misses prolonging gambling, what we are really doing is making a claim that near-misses have a reinforcing function on behaviour. One of the elegant aspects of reinforcement as a scientific concept is that it is an empirically verifiable process. We don't need to make suppositions about the mind or other hypothetical constructs. We can just measure environment-behaviour interactions and draw conclusions from them. Unfortunately, there has been relatively little research that has investigated this with respect to near-misses. Furthermore, an honest appraisal of the existing experimental literature explicitly examining the reinforcing function of near-misses provides no clear answer as to whether they are or are not reinforcers. When you look at this literature you find replication failures, inconsistencies, and various experimental confounds. Compounding these problems are large methodological differences across studies. It is a telling state of affairs that there currently exists no reliable paradigm to demonstrate a clear reinforcing function of near-misses on gambling persistence. Much of my work has been directed at testing the near-miss effect in a more experimentally controlled manner than has previously been done by building upon the successes and failures of past research.

## Much research investigating the near-miss effect has tended to involve either human subjects or rats. Why did you choose to use pigeons in your investigations?

Part of the reason for using pigeons is that there is a large historical precedent for their use in science. Darwin himself formulated many of his ideas about natural selection on the basis of the pigeons he owned. Additionally, much of the knowledge we have gained about human learning has a precursor in early laboratory examinations of pigeon behaviour. Consequently, there is a large and productive research base to draw upon where pigeons are concerned.

Another part concerns pigeons' uncanny similarity to problem gamblers. More so than any other commonly used laboratory animal, pigeons temporally discount reinforcers at very high rates. Essentially what this means is that pigeons are extremely impulsive and don't like to wait for reinforcement. This is a trait that problem gamblers and people with other addictive behaviours have also been shown to share. Pigeons' high rates of temporal discounting can actually be used to reliably generate

suboptimal forms of behaviour (not unlike that seen in instances of problem gambling).

Lastly I would say that the use of pigeons is fundamentally just very practical. Pigeons are small, intelligent, and easy to handle. Their learning histories and motivation levels can be easily controlled and they can be given large exposure to gambling contingencies that have meaningful stakes. In most cases, this is something that can't ethically be done with human participants. Pigeons will also work quite hard for little more than a few grains of food and, like humans, are highly dependent on their visual system. A pigeon will happily peck away at a touch screen monitor in a fashion eerily similar to a person on an iPad or, in the case of gambling, a person on a video lottery terminal. This is not a characteristic feature of most laboratory animals. Rats, for instance, have quite poor eyesight, which tends to limit the types of visual stimuli that will invoke a response.

## What is the procedure for training a pigeon to perform the tasks involved in a near-miss experiment?

While it depends on the experiment, in most cases very little training is actually involved. Using a procedure called autoshaping, a pigeon learns within a few minutes that pecking an illuminated circle on a touch screen will result in a delivery of food. This is the pigeon equivalent of activating play on a slot machine. Once that basic response is learned, it is then a matter of exposing the pigeon to a particular set of environmental contingencies and measuring the resulting effect on rates of behaviour. For instance, in one of my experiments I gave pigeons equivalent amounts of exposure to various possible reel patterns. I then manipulated the frequency of one of the reel patterns (e.g., a near-miss) and compared the birds' cumulative amount of responding to a control situation they were exposed to.

## What is the reason that scientists like yourself choose animal models for this type of research?

The principle reason is that animal models allow researchers to obtain experimental control over variables that would otherwise be impractical or unethical with humans. For instance, it's very difficult to accurately control a person's learning history or have them participate in an experiment for days or weeks at a time while also controlling extraneous environmental factors. Moreover, even in the most realistic gambling study, a participant knows full well that they are in an experiment. This basic fact is bound to have some influence on the results. Add to this the ethical and practical difficulties involved in recruiting problem gamblers and exposing them to meaningful gambling scenarios. In my opinion, the field of gambling research needs to incorporate investigations using both human and animal models. Neither one is, by itself, going to provide all the answers. Multiple research angles are necessary for a more complete picture.

## Your most recent investigations have examined the near-miss effect in humans using a simulated slot machine. What have you found so far? Do results indicate any similarities or differences between your human and pigeon subjects?

What we have found is that, in terms of the ability to reinforce a behavioural response, a near-miss does not appear to be qualitatively different than its opposite the far-miss. If near-misses do genuinely have the ability to prolong play, then a clear difference should have emerged between these two types of misses, but this wasn't the case. My colleagues, Joshua Yong and Marcia Spetch, and I ran two different pigeon experiments and a third human experiment that provided analogous conditions and stimuli to what the pigeons received. None of these were able to demonstrate a reinforcing function. While one has to be cautious in interpreting results such as these as "evidence of absence," a telling point is that these types of findings are not especially rare in experimental analyses of the near-miss effect. At a certain point, we need to start questioning why it is so difficult to experimentally demonstrate a reinforcing effect of near-misses.

## What do you anticipate as being the next steps in your research program?

The next step is to take differing experimental procedures that are able to establish clear reinforcement effects and apply them specifically to near-misses. For instance, we have been testing the applicability of the "Progressive Ratio procedure." This procedure is commonly used in drug self-administration experiments and requires an organism to produce increasing amounts of responses to obtain a particular consequence. How reinforcing a consequence is can be determined by looking at the point at which the organism stops responding and comparing this to an appropriate control. This procedure also has the advantage of providing valuable response rate data that can be used to determine reinforcer efficacy. Currently, most of the research trying to assess the reinforcing function of near-misses has utilized what are known as "resistance-to-extinction" procedures. While these are a valid means of testing reinforcing function, they may lack sensitivity where small behavioural effects are concerned. This could explain why there are so many notable inconsistencies in the literature.

Ultimately, in determining whether near-misses do reinforce the behaviour of gamblers, multiple avenues of experimentation must be explored. Only then will science be in a position to accurately characterize the effect, if any, near-misses have on gambling persistence.

### For More Information:

Ludvig, E. A., Madan, C. R., Pisklak, J. M., & Spetch, M. L. (2014). Reward context determines risky choice in pigeons and humans. *Biology Letters, 10*(8), 20140451. http://dx.doi.org/10.1098/rsbl.2014.0451

Pisklak, J. M., McDevitt, M. A., Dunn, R. M., & Spetch, M. L. (2015). When good pigeons make bad decisions: Choice with probabilistic delays and outcomes. *Journal of the Experimental Analysis of Behavior, 104(3)*, 241-251. http://dx.doi.org/10.1002/jeab.177

Pisklak, J. M. (2015). *Generalizing the effect of extreme outcomes in risky decision making: A cross species comparison of pigeons and humans* (Master's thesis, University of Alberta). https://doi.org/10.7939/R37S7HZ0C

# Smoking Monkeys and Gambling Pigeons: Why Animal-Based Research Into Gambling Disorder Matters

*By Darren R. Christensen, David Euston, and Marcia Spetch*

**The following letter was sent to *Global Gaming Business Magazine* in response to the article 'Smoking Monkeys, Gambling Pigeons':**

We read with interest the article by Frank Legato on 'Smoking Monkeys, Gambling Pigeons' published in your on-line magazine on December 2016. Mr. Legato asks, in a round about fashion, why does animal-based research into gambling disorders matter? As basic-science researchers who use both non-human (indeed, pigeons and rats) and human subjects to study problem gambling and other addictions, we would like to provide some context on the issue and hopefully answer this important question.

In the beginning of his column, Mr. Legato notes the case of the croupier chimpanzee John. In this example, John was an advertising gimmick used by the casino to encourage people to visit, and unfortunately for John, his drinking and smoking initiated by the gamblers resulted in poor health and an untimely death. While written in a witty, entertaining style, this case illustrates an important health issue for problem gamblers – the high association between problem gambling and other risky behaviours, such as drinking and smoking. Addictions often support each other, meaning that using one encourages the use of another, resulting in wide-ranging health effects: greater ill health and lowering the performance of protective health behaviours. The fact that these problems developed in a monkey actually highlights the similarities between animals and humans when it comes to addiction.

Later in the column, Mr. Legato implies that animal-based gambling research tells us little about the behaviour of humans in a casino. It's true that we have learned much about the causes of problem gambling from human-based research (e.g., questionnaire-based surveys). We are beginning to understand how gambling availability, psychiatric illness, and personal relationships either worsen or lessen the severity of problem gambling. However, human-based research into the causes of gambling

addictions is limited by practical and ethical constraints. After all, we cannot conduct experiments in which we make someone addicted to gambling. Further, we have yet to find any human volunteers to have wires implanted in their brains for research purposes. (While we jest about human volunteers, we take animal welfare very seriously. The scientific knowledge gained must be carefully weighed against any potential harm to the animal. In fact, all of our research follows federal guidelines and must be approved by an ethics panel.) Because of the limitations of human experimentation, we still don't know what's going on inside the brain of an addicted individual.

Why does that matter? First, knowing the underlying biology may lead to better ways to predict who is at risk of developing gambling problems. For example, animal based studies have shown that the signalling molecule, dopamine, plays a critical role in the development of addiction. Based on this knowledge, studies have identified specific mutations of the dopamine sensor within the brain which can change a person's sensitivity to reward. We don't yet know whether or not a genetic test can predict who will be at risk of problem gambling, but it surely is worth studying. Second, knowing how the brain works may lead to cures for those experiencing uncontrollable gambling urges. We hope that by identifying the signalling chemicals involved in addiction (dopamine is only one of many) we can develop drugs that help people recover from addiction. Knowing the brain mechanisms of addiction may have other benefits, such as knowing where in the brain to look for signs of improvement during therapy (e.g., using brain imaging tools such as MRI). Only by working with animal models of gambling and other addictions can we poke and prod the brain to reveal its secrets and potentially create new diagnostic and therapeutic tools.

Mr. Legato does have a valid point in that there are many differences between rats (or pigeons) and humans. Rats have much lower rates of marital discord, and pigeons never seem to have any money! What animal researchers focus on are aspects of behaviour which are common across the animal kingdom, including motivation, risk-taking, and decision-making. Because Mother Nature rarely wastes the effort to invent something new when she has a perfectly good working system, the human brain machinery underlying these behaviours

(including the use of dopamine) is remarkably similar to that in other mammals and birds. This allows us to ask questions like "what dopamine sensor mutations decrease sensitivity to risk?" — questions which we can tackle more easily with a rat, pigeon, or monkey.

As Mr. Legato mentions, the idea that random reward delivery leads to higher motivation was first discovered in non-humans. What Mr. Legato left out was that when rats and pigeons are given rewards on a predictable schedule (e.g., every 5 disk pecks leads to food) they were not nearly as motivated as those given the same amount of food on an unpredictable schedule. It's not just the food, it's the schedule that matters. And the motivational effects of these schedules, first identified in basic-science research, occur not only in pigeons, rats, etc., but also in humans. What works with food rewards for hungry pigeons also seems to work with other types of rewards including social praise or winning money (i.e., gambling). Based on this insight, we and many researchers suspect that random schedules are at the core of how problem gambling develops; however, because we don't know what unpredictable reward does in the brain, this is an important focus in our research.

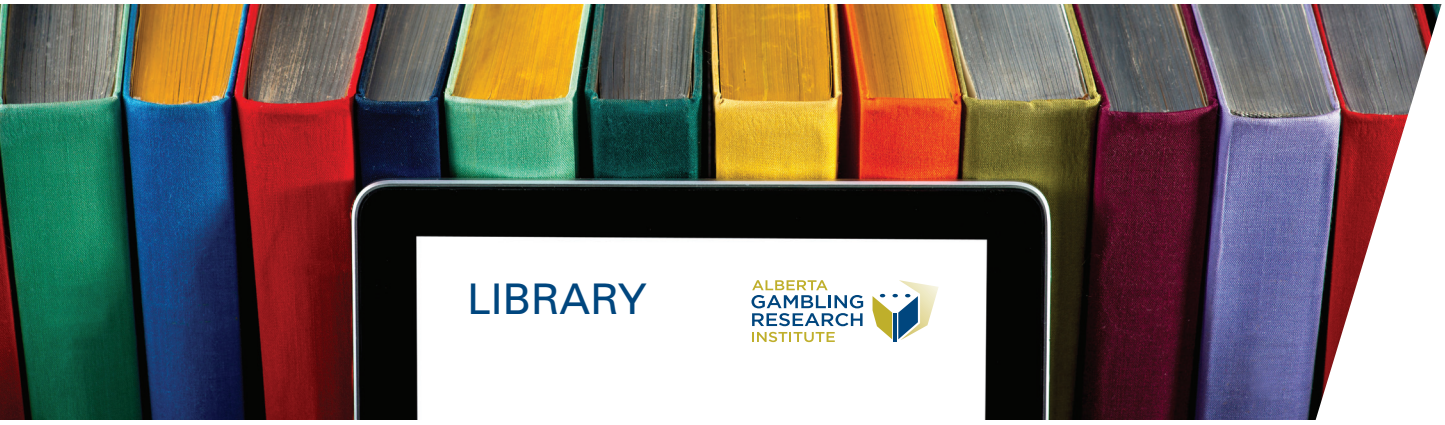
Because animals are simpler than humans and can provide more direct tests of underlying causes, animal models are an important piece of the overall research picture needed to fully understand the process of addiction. With this knowledge, we may one day be able to predict who can enjoy recreational gambling and who is at risk of developing problems. Further, we may be able to treat those who have lost control. We believe very strongly that animal research is much more than a circus act!

**Sincerely,**

***Darren R. Christensen, Faculty of Health Sciences, U. of Lethbridge***

***David Euston, Department of Neuroscience, University of Lethbridge***

***Marcia Spetch, Department of Psychology, University of Alberta***




# FROM THE LIBRARY... A Bestiary of Risk-Taking Among Non-Human Species

**Investigators from several academic disciplines – including behavioral ecology and neuroscience -- have taken a particular interest in seeking to understand risk-taking and decision-making in animal species. The following citations provide examples from the scientific literature:**

## ANIMAL MODELS (GENERAL)

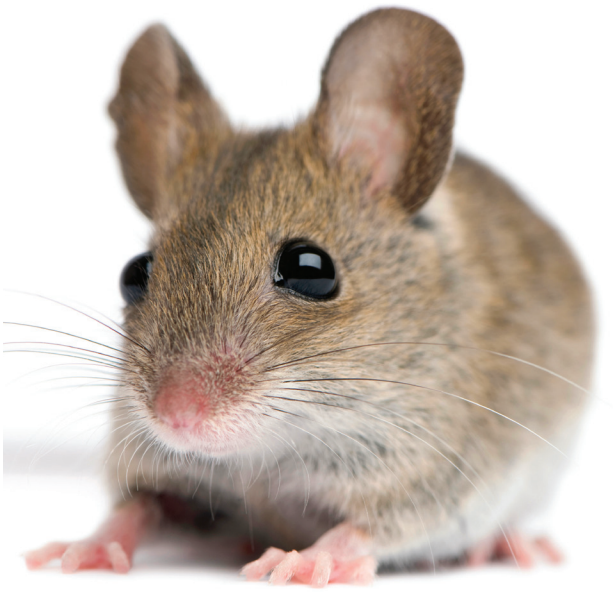
"Beyond the ability to arrange ecologically valid and important consequences, the study of gambling in animal subjects opens the possibility of conducting meticulously controlled experiments in which pharmacological variables are manipulated and neurological measures taken."
(Madden et al., 2007, p.64).

- Winstanley, C. A., & Clark, L. (2016). Translational models of gambling-related decision making. In T. W. Robbins & B. J. Sahakian (Eds.), *Current topics in behavioral neurosciences: Translational neuropsychopharmacology* (pp. 93-120). Switzerland: Springer. http://dx.doi.org/10.1007/978-3-319-33913-9
- Madden, G. J., Ewan, E. E., & Lagorio, C. H. (2007). Toward an animal model of gambling: Delay discounting and the allure of unpredictable outcomes. *Journal of Gambling Studies, 23*(1), 63-83. http://dx.doi.org/10.1007/s10899-006-9041-5

## PRIMATES – CHIMPANZEES, BONOBOS & CAPUCHIN MONKEYS

"Researching other primates' decisions in risky contexts may help to elucidate the evolutionary pressures that resulted in human gambling behaviors." (Proctor, 2012, p.7)

- De Petrillo, F., Ventricelli, M., Ponsi, G., & Addessi, E. (2015). Do tufted capuchin monkeys play the odds? Flexible risk preferences in Sapajus spp. *Animal Cognition, 18*(1), 119-130. http://dx.doi.org/10.1007/s10071-014-0783-7
- Proctor, D., Williamson, R. A., Latzman, R. D., de Waal, Frans B. M, & Brosnan, S. F. (2014). Gambling primates: Reactions to a modified Iowa Gambling Task in humans, chimpanzees and capuchin monkeys. *Animal Cognition, 17*(4), 983-995. http://dx.doi.org/10.1007/s10071-014-0730-7
- Proctor, D. (2012). *Gambling and decision-making among primates: The primate gambling task.* Dissertation, Georgia State University. http://scholarworks.gsu.edu/psych_diss/108
- Rosati, A., & Hare, B. (2013). Chimpanzees and bonobos exhibit emotional responses to decision outcomes. *Plos One, 8*(5), e63058. http://dx.doi.org/10.1371/journal.pone.0063058



## RODENTS – RATS & MICE

"The rSMT [rodent slot machine task] is a complex conditional discrimination task roughly analogous to a simple slot machine"
(Cocker & Winstanley, 2015b, p.263).


- Cocker, P. J., & Winstanley, C. A. (2015a). Towards a better understanding of disordered gambling: Efficacy of animal paradigms in modelling aspects of gambling behaviour. *Current Addiction Reports, 2*(3), 240-248. http://dx.doi.org/10.1007/s40429-015-0065-8
- Cocker, P., & Winstanley, C. A. (2015b). Irrational beliefs, biases and gambling: Exploring the role of animal models in elucidating vulnerabilities for the development of pathological gambling. *Behavioural Brain Research, 279*, 259-273. http://dx.doi.org/10.1016/j.bbr.2014.10.043
- Laskowski, C. S., Williams, R. J., Martens, K. M., Gruber, A. J., Fisher, K. G., & Euston, D. R. (2016). The role of the medial prefrontal cortex in updating reward value and avoiding perseveration. *Behavioural Brain Research, 306*, 52-63. http://dx.doi.org/10.1016/j.bbr.2016.03.007


## BIRDS – PIGEONS

"The results of these experiments suggest that pigeons show a tendency to make maladaptive decisions similar to those of humans"
(Zentall & Stagner, 2011, p.1206).


- Pattison, K. F., Laude, J. R., & Zentall, T. R. (2013). Environmental enrichment affects suboptimal, risky, gambling-like choice by pigeons. *Animal Cognition, 16*(3), 429-434. http://dx.doi.org/10.1007/s10071-012-0583-x
- Zentall, T. R., & Stagner, J. (2011). Maladaptive choice behaviour by pigeons: An animal analogue and possible mechanism for gambling (sub-optimal human decision-making behaviour). *Proceedings: Biological Sciences, 278*(1709), 1203-1208. http://dx.doi.org/10.1098/rspb.2010.1607


## OTHER SPECIES – RISK-SENSITIVE FORAGING

"Whether animals are risk-averse or risk-prone appears to depend on a range of factors, including the energetic status of the forager, the type of variance associated with the feeding options and even the number of feeding options between which the animal is choosing." (Bateson, 2002, p.1)


- Bateson, M. (2010). Rational choice behaviour: Definitions and evidence. In M. D. Breed & J. Moore (Eds.), *Encyclopaedia of animal behavior* (pp. 13-19). London: Academic Press. https://www.staff.ncl.ac.uk/melissa.bateson/Bateson_2010.pdf
- Bateson, M. (2002). Recent advances in our understanding of risk-sensitive foraging. *Proceedings of the Nutrition Society, 61*(4), 509-519. https://www.staff.ncl.ac.uk/melissa.bateson/Bateson_2002b.pdf
- Kacelnik, A., & Bateson, M. (1996). Risky theories: The effects of variance on foraging decisions. *American Zoologist, 36*(4), 402-434. https://www.staff.ncl.ac.uk/melissa.bateson/Kacelnik_Bateson_1996.pdf

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