Why you DON'T always need to feed after each click

(V. 1.1)

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1) Introduction

SPARCS is a great organization that has made available some very interesting dog relevant topics from the depths of science. It's of special interest, because scientists get up on stage and speak in normal English talking about some of the research they've been doing, to people who may not be conversant in science-speak.

Many months ago, I remembered the dog training world being torn asunder by a speaker at the SPARCS 2014, Dr. Simon Gadbois, who almost passingly suggested, that it wasn't necessary to follow every click with food. The heretic had spoken: he'd dared suggest not giving a treat to a dog after a click, breaking the holy contract with the dog.

At first I too could not accept this. My training itself had been too thorough. After all, I am the holder of a certificate proclaiming that I am a Swiss Clicker Trainer, having taken part in the first such certificate class offered in Switzerland. Also we had learned all about primary reinforcers and secondary reinforcers and why one must always follow the secondary with a primary reinforcer or the reinforcing association would be lost.

I however, without telling anyone, like a "closet clickerer", did some experiments with my trusting Vela. I tried some things like NOT feeding her after every click. Or not feeding her after every "good", the signal (secondary or conditioned reinforcer) I'd introduced according to the suggestion, *if you wanted to use a sign that did not have the same weight as the clicker, where you could leave out the food now and again* . And what did I notice? **Nothing** except that it seemed, that her enthusiasm for the time after BOTH that click or "good" increased over simply strictly following protocol. And this seemed to be able to go on for 6-8 (or more, I never went further than that) trials without food (primary or unconditioned reinforcer) – it made no difference whether this was after clicks or after "good", before I delivered the treat. We had some really productive sessions. I felt ... dirty, violated. She always wanted more.

Next came a training session with a colleague who observed me. Like the "closeted clickerer" I was, I only used my "good" in her presence. Despite that, we somehow got into that discussion about the inevitability of following the click with a treat and ... she was absolutely convinced, you ruin the clicker if you don't treat after every click, but you don't ruin a "good". I was **doing it WRONG**. AND this colleague told me about a dog dance trainer who had held an entire seminar on such "bridges" which operate totally differently than a clicker. ????

And so it went, as did however, also my curiosity. How can a scientist, reporting on studies done in the field with olfaction search dogs, make such a claim that went against all science presented to me (what science HAD actually been presented to me?)? And with such fervor, that he said at the end, that he can't understand the resistance of trainers to this idea? One well known trainer, in a side remark about studies done with animals, even made the suggestion about other scientists doing animal research, that they aren't really very good trainers anyway. So, I decided to "look it up".

This new "paper" is going to look at some of the "things we Clicker Trainers know", where they came from and if they can be substantiated in science with empirical data. As usual, I will first define some terms, giving the sources of these definitions. I will then look at how "we" use these terms, not just from my own experience, but from the people who are teaching "us". Then I will present some information that either supports and/or refutes what "we" have learned. And as a spoiler, "science" is unfortunately NOT as black/white as we "science-based" trainers would like it to be. For many, many things there is actually data for and against. It's also MUCH more complex than we'd like it to be, so I'll try to show how asking the wrong question WILL get you the answer you're looking for, but not necessarily the right answer, and give an example of this, or maybe two. I'll be looking at research mostly from the behaviorism/psychology side, but also from the neuroscience side, since neuroscience is an -ology that actually DOES understand the behaviorism/psychology, as they are looking for explanations for behavior from another perspective, meaning from the cellular and sometimes molecular perspective.

Since I am NOT a scientist, this is NOT a science paper. It is however a presentation of some of the science involved with what we call "Clicker Training" or even "Marker Training" and I do show the original sources. Please feel free to suggest peer reviewed studies or reviews of such studies which either support or refute the empirical data presented here.

2) Some terms in common usage

I consulted the following general psychology glossaries to look up these terms:

American Psychological Association (APA) - http://www.apa.org/research/action/glossary.aspx

ABA the Science of Behavior - http://www.scienceofbehavior.com/lms/mod/glossary/view.php?id=408

AlleyDog Psychology Glossary - http://www.alleydog.com/glossary/psychology-glossary.php

Behaviorspeak[1], A Glossary of Terms in Applied Behavior Analysis

Learning and Behavior, Active Learning Edition, *Sixth Edition*[2]

Behavior Modification, Principles and Procedure[3]

Learning Behavior and Cognition, 3rd Edition[4]

and also from these "dog" or "animal" sources:

Association of Animal Behavior Professionals (AABP) Glossary - http://www.associationofanimalbehaviorprofessionals.com/glossary.html

Karen Pryor Clicker Training Glossary - http://www.clickertraining.com/glossary/17

Reaching the Animal Mind[5]

How Dogs Learn[6]

And here are the terms. For most of the terms, there is a general consensus on what they mean, I will therefore choose a couple at random that are representative for all – since all sources are given, please feel free to double check these. If there are important differences, I will quote these also as well as their source. There are a couple of terms that were not found in all glossaries or sources. I will indicate these. *Direct quotes are italic*. Summaries are in normal typeface.

Primary reinforcer / unconditioned reinforcer:

APA Glossary *Biologically determined reinforcers such as food and water.*

Chance, Learning and Behavior (2008) *...primary reinforcers are those that are not dependent upon on their association with other reinforcers.*

Karen Pryor Clicker Training Glossary *A reinforcer that the animal is born needing. Food, water, and sex are primary reinforcers.*

Lieberman, Learning Behavior and Cognition – writes that visual reinforcers are included as **sensory reinforcers**[7] by some scientists, a sub-group of primary reinforcers.

Secondary reinforcer / conditioned reinforcer:

APA Glossary *Reinforcers that are dependent on their association with other reinforcers*

Chance, Learning and Behavior *(2008) ...are those dependent upon their association with other reinforcers.*

1 Newman, Bobby; Reeve, Kenneth F.; Reeve, Sharon A.; Ryan, Carolyn S., (2003)
2 Chance, Paul, (2008)
3 Mittenberger, Raymond G. (2008)
4 Lieberman, David A., (2000)
5 Pryor, Karen (2009)
6 Burch, Mary R.; Bailey, Jon S., (1999)
7 Lieberman, David A., (2000) p. 204-205

(P. 135) *Of course, a buzzer that acquired reinforcing power by being paired with another reinforcer will lose its effectiveness if it is never followed by a reinforcer again.*
And writing about clickers as secondary reinforcers on p. 138 *If the clicks are at least sometimes followed by food, they will remain reinforcing.*

(AABP) Glossary *A reinforcer effective because it has been previously paired with an unconditioned reinforcer or an already established conditioned reinforcer. Also called a secondary reinforcer.*

Karen Pryor Clicker Training Glossary

Conditioned reinforcer: *A neutral stimulus paired with a primary reinforcer until the neutral stimulus takes on the reinforcing properties of the primary. A clicker, after being repeatedly associated with a food treat or other reinforcer, becomes a conditioned reinforcer.*

Secondary reinforcer: *A conditioned reinforcer. A reinforcer the animal is not born needing. Secondary reinforcers may be as, or even more, powerful than a primary reinforcer.*

Reinforcement schedules:

Mittenberger, Behavior Modification, Principles and Procedures

A CRF schedule is used when a person is learning a behavior or engaging in the behavior for the first time. This is called ***acquisition****: The person is acquiring a new behavior. Once the person has acquired or learned the behavior, an* ***intermittent reinforcement schedule*** *is used so that the person continues to engage in the behavior. This is called* ***maintenance****: The behavior is maintained over time with the use of intermittent reinforcement.*

Continuous Reinforcement (CRF)1:1 reinforcement, technically also FR1 – see below

AABP Glossary:

FIXED-RATIO SCHEDULE: In a fixed-ratio schedule of reinforcement a fixed number of performances (counted from the preceding reinforcement) are required for reinforcement. Thus on an FR 50 schedule, the fiftieth performance after the preceding reinforcement produces the next reinforcement. The term ratio refers to the ratio of performances required for each reinforcement.

VARIABLE-RATIO SCHEDULE: A schedule of intermittent reinforcement under which reinforcements are programmed according to a random series of ratios having a given mean and lying between arbitrary extreme values.

ABA Glossary:

FIXED INTERVAL: A schedule of reinforcement in which an operant is reinforced after a fixed amount of time has passed. For example, on a fixed-interval 90-second schedule (FI 90 second), one bar press after 90 seconds results in reinforcement. Following reinforcement, another 90-second period goes into effect; and after this time has passed, another response will produce reinforcement.

VARIABLE INTERVAL :A schedule of reinforcement in which one response is reinforced after a variable amount of time has passed. For example, on a VI 30-second schedule, the time to each reinforcement changes but the average time is 30 seconds.

Tertiary or Intermediate reinforcer:

ABA Glossary:

A stimulus that functions as a reinforcer because of its contingent relation to another reinforcer. Such stimuli have also been called secondary reinforcers, but this designation is best reserved for cases in which the modifier specifies how many stimuli separate the conditioned reinforcer from a primary reinforcer (e.g., a secondary reinforcer is followed directly by a primary reinforcer, a tertiary by a secondary, etc.). In some cases, convenience dictates the assigned order (e.g., a feeder operation may be called a primary reinforcer even though the auditory and /or visual stimuli that accompany it are actually conditioned reinforcers that precede eating).

Reaching the Animal Mind Glossary

P. 241 *Tertiary reinforcers indicate a behavior leading to a secondary and primary reinforcer.*

P. 242 ...*Tertiary Reinforcers. A technical term for the cue i.e., a discriminative stimulus, for an action that leads to reinforcement, never punishment.*

Note: these are the only 2 glossaries of those consulted and listed above which mention either "tertiary" or "intermediate" reinforcers. They are both not general science glossaries, but rather "animal glossaries".

event marker:

Karen Pryor Clicker Training Glossary

A signal used to mark desired behavior at the instant it occurs. The clicker is an event marker.

Reaching the Animal Mind Glossary

P. 240 – Glossary: states, that Ogden Lindsley, founder of "Precision Teaching" and one of Skinner's early graduate students, coined the term "event marker", to mean a secondary reinforcer given to mark the moment a desired behavior occurs. The shortened term "marker" comes from this and is a trainer's term as Pryor writes.

Note: these are the only 2 glossaries of those consulted and listed above which mention "event marker". They are both not general science glossaries, but rather "animal glossaries".

bridging stimulus:

AABP Glossary: *(bridge) see Conditioned Reinforcer*

Karen Pryor Clicker Training Glossary: *An event marker that identifies the desired response and "bridges" the time between the response and the delivery of the primary reinforcer. The clicker is a bridging stimulus.*

Note: these are the only 2 glossaries of those consulted and listed above which mention "bridge" or "bridging stimulus". They are both not general science glossaries, but rather "animal glossaries".

In the course of this paper there will be other vocabulary introduced but it will always be accompanied by a source definition, often as part of the study or review cited.

3) Reinforcers: common usage vs. evidence based

What can we notice about this vocabulary list above? This list contains some of the most important terms we need to know and deal with in dog training. Some of the terms we use seem to be primarily or even exclusively used in animal training. We don't dwell on these definitions. At one point we learned them and now we "know" them. But ... are these really the definitions we've learned? Which ones? One thing to note is, that "dog people" or "animal people" have either created some terms that they find useful or bent some original meanings to new ones, where useful. For example the terms "event marker", "bridge" and "tertiary (intermediate) reinforcer". This is not to say, that the three are not found in "the literature". They are, however, if found at all, found extremely rarely and either in other works by animal people or even lamented as "unnecessary"[8].

Some standard definitions also have been slightly bent. One only really sees how much, when one compares the surrounding text in a textbook or how that term is used in general scientific usage. We're going to look into that in a minute.

To recap, Dr. Gadbois made a simple statement, that one does not need to give a primary reinforcer (unconditioned reinforcer) after every click. In a semi-private conversation he said, that this is actually common knowledge, covered in every Psych 101 text book. Is that true?

When we examine the quoted definitions above for a secondary reinforcer (conditioned reinforcer), we see no such obligation, that a secondary reinforcer MUST be followed by a primary reinforcer, or it will have dire consequences for animal or clicker. There is a qualification that if you don't deliver a primary (unconditioned) reinforcer **at all**, the association will fade and disappear. But that leaves a couple of other questions:

1) Are there maybe different classes of secondary reinforcers, like one for clickers and one for other secondary reinforcers?
2) Is there any empirical data showing how strong/weak this association is?
3) Are there any other problems with not giving a primary to every secondary?

I think we first have to look at where we are in the Clicker Training world.

3.1 Secondary reinforcers: The dog peoples' perspective

There is no doubt, that Karen Pryor and her Academy is the gold standard in terms of Clicker Training. Many other people teach Clicker Training, but they are the others. She wrote the first introduction to reinforcement training, also covering the clicker in 1984, "Don't Shoot the Dog", aimed at a general public. When I did my certificate at CASI, her "Getting Started: Clicker Training for Dogs" (2005) was on the recommended reading list. As soon as it came out, I too bought and read "Reaching the Animal Mind" (2009). When there is a question as to how to do something you hear discussions like "*At the seminar, we learned...*" and "*But Karen Pryor says...*" and the "discussion" is settled. There are very few Clicker Trainers with the guru status enough to contradict Karen Pryor.

So let's see what she has written in these 3 books:

1) "Don't Shoot the Dog" P. 171 *The click is for training only. Once the learner has learned what you set out to teach it, you can put the clicker away.* She does not write it may be replaced by another marker, but she does write that you can use the clicker again, if you need to refresh a

8 (Kelleher & Gollub (1962)
(footnote) 4 *The popular use of the term secondary reinforcement is unfortunate because it does not encourage an analysis of the processes involved in developing a stimulus as a reinforcer. The use of the term conditioned reinforcement emphasizes the conditioning process, and makes it unnecessary to use awkward and confusing terms such as tertiary and quarternary reinforcement.*

behavior.

2) ditto P. 17-18 she describes the use of a "keep-going signal", which is a secondary reinforcer in marine animal training: the animal should keep doing what it's doing and that food will eventually come.
3) ditto P. 21- she writes about variable schedules of reinforcement. *A variable schedule is far more effective in maintaining than a constant, predictable schedule of reinforcement.* She writes (p. 22) *The longer the variable schedule, the more powerfully it maintains behavior.* She does not write, that these need to be reinforced by a primary reinforcer or if one can do so with only a secondary reinforcer or if so, what/which secondary reinforcer.
4) Getting Started: Clicker Training for Dogs (2005) p. vii *Clicker training does not depend upon the clicker or on food. Clicker training depends on reinforcers....*
5) ditto P. 3 *The dolphin is not working for the fish, the dolphin is working for the whistle.* The whistle in this case is the secondary reinforcer instead of a clicker. The importance of this will be discussed later.

Right up front, and we'll look more closely at this later: **there is no law in science stating that after acquisition of the desired behavior, one must first deliver a conditioned reinforcer and then an unconditioned reinforcer – outside of some corners of animal training**. Karen Pryor (1985) (p. 17) wrote, that in the beginning, she had to install the "one click, one treat" rule because too many crossover trainers were being stingy with the treats; clicking too often without treating. That is a methodological situation, presented as "best practices" for the use of a clicker with animals, but as Pryor states above, only in the acquisition phase. So why do "we" do it so, and keep doing it, many all the time, way after the acquisition phase is long over?

But ... one can very easily simply NOT use a clicker and when your dog sits, simply deliver the dog a treat without any conditioned reinforcer. If I were a betting man, I'd bet, that many clicker trainers do this even with a clicker in their hand. And then they say afterwards "That's a good boy." Done in that order (sit → treat → good boy), the treat is just a primary reinforcer and "good boy" is ??? "Good boy". And I bet the dog will still have worked out, that he got that treat for having placed his bum on the ground. However, if your dog finds the word "good" reinforcing, probably because often after that word "good", chicken appears, then you can use that "good" as a conditioned reinforcer because it lets the dog know the food is coming. The word itself is not intrinsically reinforcing. It's reinforcing in the situational combination of preceding the food delivery, not afterwards. Saying "That's a good dog" after having given the food doesn't weaken the word "good" as a secondary reinforcer if spoken before the food delivery. And as Karen Pryor writes[9]: *The dolphin is not working for the fish, the dolphin is working for the whistle*[10]. The whistle in this case is the secondary reinforcer instead of a clicker.

Now, in the space of a couple of paragraphs, we have 3 different secondary (conditioned) reinforcers. A whistle, a "good" and a Clicker – if the situation is correct. Is there any literature stating, that any one of these three is any more robust or weaker than the other(s) or have any other innate characteristics than the others?

NO! Not in terms of retaining or losing association to the unconditioned reinforcer.

Pryor (2005) *A neutral stimulus paired with a primary reinforcer until the neutral stimulus takes on the reinforcing properties of the primary. A clicker, after being repeatedly associated with a food treat or other reinforcer, becomes a conditioned reinforcer.*

It's important to note, that Pryor does not state, that only a clicker can serve as a conditioned

9 Pryor, Karen (2005) p. 3
10 Ditto

reinforcer. She only uses the clicker as an example in the second quoted sentence above. It's also important to note, that once conditioned, the conditioned reinforcer takes on the reinforcing properties of the unconditioned (primary) reinforcer. But is this just one woman's opinion? Not really. Patricia McConnell (2014) states *Experimental research suggests that it is "seeking" rather than "liking" that best motivates an individual to learn. For example, Gadbois mentioned one of Panksepp's studies in which cats were always given a reward when they touched one object, but only occasionally when they touched a second object. Guess which object the cats touched most? You got it, the second one. That is why Gadbois argues that clicker trainers should not give a treat every time they click. This all makes great sense to me until I think of chocolate, which I would much rather eat than anticipate eating, thank you very much.* **Liking** and **wanting** is something I'll touch on a bit later. And as she points out rather coyly, no rule without its exception or perhaps either better, that the exceptions are accounted for in the statistics. (Almost) nothing in science is 100%. Interestingly enough, this results with Panksepp's cats seems to violate a law I'd learned by content, but not by name – but I'll get to that.

On the other hand, Jean Donaldson (2009, p. 137) in a heeling exercise outlines the use of praise as a bridge, although she does not use the words primary reinforcers or secondary reinforcers, nor does she really cover the topic of "fading" primary rewards, outlines in a heeling exercise the use of praise as a bridge. Donaldson recommends using steps *One, Two, Three, PRAISE, PRAISE, PRAISE, pay* with "PRAISE" being some reinforcing word and "pay" meaning to deliver the food. At this point, the word PRAISE takes on the role of a secondary reinforcer while the food is a primary reinforcer. She recommends therefore in this case waiting until several secondary reinforcers have been given, before then "paying". But shortly after that on P. 147 she writes: *The Rules: always pay after clicking, even if you click accidentally ...*, so these two sets of instructions seem to contradict each other, because she doesn't otherwise differentiate between a clicker as a conditioned reinforcer and PRAISE as a conditioned reinforcer.

Pat Miller, (2008) mentions a strategy that many use. They use a clicker ALWAYS paired with food while they will sporadically leave off the primary after other secondary reinforcers: *Reward Markers should always be followed by a reward so that the dog learns to trust in the marker's message that a treat is coming. ... My personal rule is that a click! always gets a food treat, while my verbal marker might be followed by a treat or, alternatively, by a high-value life reward such as the opportunity to chase a ball or frisbee, go for a walk or ride in the car, of the chance to run outside and play with their dog pals.*. This is how I learned it in Dog Dance instruction as well as in my Swiss Clicker Certificate Course. The implication being, that the clicker is somehow a different class of secondary reinforcer than another marker sound or marker word. As we'll see, science does NOT support this view.

3.2 Secondary reinforcers: The evidence based perspective

Lieberman (2000) doesn't deviate from, for example, Chance (2008) or Mittenberger (2008) in terms of how he defines reinforcers. Instead he additionallys states, that one of the first to examine exactly what secondary reinforcers are, was John B. Wolfe (1936). Wolfe first trained 6 chimps to earn grapes (primary reinforcers) for sticking tokens (secondary reinforcers) into a slot. Then they learned to get more tokens by pressing a lever. He found, that they would work just as hard for the tokens as for the grapes. Wolfe showed the equal power of reinforcement of both secondary and primary reinforcers. So add "tokens" to the list of possible conditioned reinforcers. Wolfe also introduced the idea, that essentially reinforcers are reinforcers are reinforcers as long as they have the properties necessary to reinforcer behavior. So while the tokens may not in and of themselves taste very good, they predict that the grapes, fish or chicken, depending upon what animal is being trained, are coming.

Chance (2008) and Miltenberger (2008) both state, that the conditioned reinforcer will remain reinforcing if is at least occasionally paired with the original unconditioned reinforcer, but will eventually lose it's reinforcing properties if never paired again. Burch and Bailey (1999) p. 20 *For the conditioned reinforcer to **maintain** (N.B. - emphasis Burch and Bailey) it's effectiveness, it should be followed occasionally (such as every third to tenth time) by the primary reinforcer, food.* This, is how extinction works: "*Extinction In conditioning, the weakening of a conditioned association in the absence of a reinforcer or unconditioned stimulus*.[11]" Karen Pryor (1985) describes the use of a "k*eep-going signal*", which is nothing more than a secondary reinforcer in marine (and dog training – LC) training, that the animal should keep doing what it's doing and that food would eventually come. So between the psychology texts and the most authoritative source for Clicker Training, we have a very general idea, that it's **not** necessary to give a primary reinforcer after every secondary reinforcer, and that doing so does not damage the strength of the secondary reinforcer. And we also see, that a clicker is not some kind of special case.

Now we're entering the "dangerous" area. What empirical evidence is there for these statements above? One of the first questions that needs to be answered, is; whether or not a secondary reinforcer is strong enough to train a new behavior without any primary reinforcer. Anyone who has a ball-crazed or stick-crazed dog knows the answer to this. While "play" in and of itself, is generally considered to be a primary reinforcer, since most animals don't need to be conditioned to play, most do need to be conditioned to play with certain objects. If you place a ball on the ground in front of most dogs who've never played with one, they will not automatically play with it. The same with a stick. Even if your throw it, most dogs will either watch it fly or maybe go investigate it when it lands, but the idea to bring it back and start again, or to tug with it, needs to be taught to most dogs, even if this teaching (conditioning) goes very quickly. However, when taught (conditioned), it can take on the same characteristics as a primary reinforcer. And then Karen Pryor already stated; the dolphin works for the signal, not the food[12].

Zimmerman (1957; 1959) showed the same ability in secondary reinforcers, both in fixed and in variable ratios of reinforcement to teach and maintain learning, but the controls were not such, that all external influences could be ruled out in this respect[13]. Sosa et al (2011) investigated the question, whether one can just use a secondary reinforcer to teach a new behavior. The resounding answer – YES!

3.3 Matching Law – a problem with how we handle secondary reinforcers?

There was however some concern expressed by colleagues concerning the "Matching Law" by R.J. Herrnstein (1961). He described it in pretty plain English:

> ***Suppose alternative A pays off one time in five and alternative B pays off one time in 10. Probability matching implies a 2:1 ratio of choices for A and B respectively...***[14].

"Alternative A" and "alternative B" are to be understood as behaviors. There are some who try to apply this to all behaviors[15]*: Since the early 1960s (Herrnstein, 1961), behavior analysts have theorized that choice (i.e., relative preference) may be understood—and accurately predicted—by examining relative rates of reinforcement associated with each option (e.g., pecking one of two keys, choosing one worksheet over another, emitting appropriate or problem behavior). In this conceptual framework, relatively dense sources of reinforcement will feature relatively higher rates of behavior (i.e.,*

11 http://www.apa.org/research/action/glossary.aspx?tab=5
12 Pryor (2005) p. 3
13 Sosa et al (2011)
14 Herrnstein and Loveland (1975)
15 Reed and Kaplan (2011)

organisms demonstrate preference for the most reinforcing events/settings).

However, when one more closely examines under which conditions this law is generally applied in real life[16] [17], as well in what conditions Herrnstein himself researched it[18], meaning: either/or two distinct secondary reinforcers and/or two distinct possible behaviors, it becomes clear, that he was interested in researching the mechanism of **choice** between several possibilities. In a very, very stretched manner, when training a new behavior with a dog, one could say, that if chasing a squirrel has been reinforced more often than laying down, the dog will probably choose chasing the squirrel – according to Matching Law. But this type of choice is rarely -if ever- encountered when professionally teaching new behaviors, nor when generalizing not-quite-so-new ones. Therefore it's more than a far stretch to use Matching Law to argue that one MUST give a primary reinforcer after secondary or risk not getting the more reinforced behavior. Besides, although you could start even only training using the click with no food at all, who does this in real life and why would you want to, with the present information? The point here being, that the research showing the relative strength of a secondary reinforcer without or only sporadically with a primary reinforcer, was always done in a physical situation of linear trials: one cue → one target behavior (no choice between two possible behaviors) → one secondary reinforcer → one primary reinforcer if given[19]. Matching Law has to do with actively presented choices between two or more presented possible behaviors, not theoretically imagined ones.

3.4 What about schedules of reinforcers?

Intermittent schedules of reinforcement (see above in the definitions part) are very efficient and powerful. One can either use a secondary reinforcer, a primary reinforcer, or both for these schedules, or different combined[20] overlapping reinforcement schedules. Karen Pryor (2005) writes: *The longer the variable schedule, the more powerfully it maintains behavior.* and later states, also inferring, the usage of a variable reinforcement schedule: *How much more effective it would be to shape the pose, develop a verbal cue, and then reinforce the dog with a click for assuming and holding he proper posture for a respectable length of time – with the actual food following later outside the ring or when the judge has moved on.* which confirms in real-life, what Kelleher (1957) and Zimmerman (1957) established in the lab. The whole idea of these is, that a primary reinforcer is not given for every correct execution of a targeted behavior, but rather either at **fixed ratios** (1:X successful executions), **variable ratios** (1:an average of a certain amount of executions), **fixed interval**s (1:every x minutes, hours, even longer) or **variable intervals** (1:of an average of a number of time increments).

Hochman and Erev (2013) show, that the use of non-CRF schedules of reinforcement, meaning intermittent of various types accomplishes two things: increases the resilience and robustness of learned behavior as well as protects the learned behavior from extinction. This effect was first described by Humphreys (1939) and is known as the **partial-reinforcement extinction effec**t (PREE).

Kelleher (1957) continued this work, but was the first to actually include research with animals for schedules of reinforcement. He was followed by Zimmerman (1957; 1959), who wrote (1957): *It has been the purpose of this paper to discuss a method by which secondary reinforcement can be made highly effective and stable, thus giving the needed empirical buttressing to the kind of theorizing cited. This method depends upon the use of intermittent reinforcement, thereby also further accenting the very great importance of the intermittent reinforcement technique for psychological theory.* Kelleher

16 Martens and Houck (1989)
17 Neef et al (1992)
18 Herrnstein (1961; 1964)
19 Wolfe (1936), Cowles (1937), Zimmerman (1957; 1959)
20 http://www.educateautism.com/applied-behaviour-analysis/schedules-of-reinforcement.html

reported that in his experiments done with tokens (poker chips) using fixed-ratio schedules of reinforcement going up to 1:125, the animals all successfully continued to work for tokens, although he did remark that by lower ratios, the performance speed picked up slightly just before the trial that actually paid the primary reinforcer. At higher ratios, there was however a slight slowing of response depending upon the exact number from 4 responses to 2 responses per second (no typo – per second!) a response being the tapping a telephone key in the presence of a white light, but none stopped responding. Kelleher concluded: *Performance on FR schedules of food reinforcement is characterized by high, stable rates of responding.*

3.5 Intervalic schedules of reinforcement and "Token Economies"

The important thing to note in Kelleher and Zimmerman, as well as Wolfe (1936) and Cowles (1937) before them is, that there was an extensive "training" period for all animals during which the subjects learned the concept in a CRF schedule that a "Token" (conditioned reinforcer) promised food and what the desired behavior was. Especially Wolfe and Cowles did different experiments to see whether one could use tokens as unconditioned reinforcers alone and not surprisingly, they didn't work as well. But then, once conditioned, they worked as well or better than the food alone. When testing fixed ratio reinforcement schedules, Kelleher was able to, and this is key, **gradually** increase the ratio from FR1 to as much as FR125 and still evoke the correct responses. That means 1 primary reinforcer for 125 correctly executed behaviors!

This work, as well as the work by Malagodi, (1967), O'Leary et al (1969), Sousa and Matsuzawa (2001), Addessi et al (2011) all used various types of secondary reinforcers (tokens) consisting of different bjects including, but not limited to, marbles and poker chips. Sousa and Matsuzawa (2001) also showed, that their chimps learned using only tokens without primary reinforcers and that the chimps even saved (!!) tokens, instead of "cashing them in" for possible primary reinforcers. O'Leary et al (1969) described a successful implementation of a token reinforcement system in a special education class of 17 children in a public school. Doll et al (2013) in their review of the history of Token Economies usage write:

This analysis has compiled evidence of effectiveness across school and community settings; however, token- reinforcement systems have seen remarkably diverse applications in prisons, military organizations, and psychiatric hospitals.

The work on secondary reinforcers combined with intermittent reinforcement schedules was so successful in showing the resilience and effectiveness of conditioned reinforces, in learning situations as well as in other motivationally driven activities, that a whole new learning strategy was established under the name "Token Economy"[21]. The idea of giving a secondary reinforcer and not following it immediately or for every successful trial, is such a well known concept, that it is pretty much accepted in real life educational situations in many walks of life – just not in animal training.

This is how a "Token Economy" as a **fixed interval reinforcement schedule** (FIx) could be implemented in a school. First one settles on what one wants to use as the primary reinforcer, and then what kind of "token" is to serve as the secondary reinforcer. Money is usually given as a prime example of a "token", because it's tied to anything one can exchange it for. This type of secondary reinforcer is a **generalized conditioned reinforcer**[22]. One then determines the reinforcement schedule for the tokens. For example one can get a token for every correct answer or for being quiet for X amount of time. And then either how many Tokens one has to save before one can cash them in for the "Commodity" (primary reinforcer or secondary reinforcer) or perhaps how many "commodities" one can gather for how many saved Tokens. This of course stands in direct conflict with the incorrect idea, that if you don't immediately follow every secondary reinforcer

21 Doll et al (2013)

22 http://www.scienceofbehavior.com/lms/mod/glossary/view.php

with a primary, the association will fade or decay. **In other words, also in a Token Economy, a primary reinforcer is not simply given after every secondary reinforcer – and there is no decay of either behavior or association between the secondary and primary reinforcers!**

Another well known example of a "Token Economy" is that of merits and demerits in schools and the military. Merits are awarded for good behavior and/or good results, demerits are given for rule infractions or bad performance. These are an example of a **fixed interval schedule of reinforcement**, cashed in on the first of the month for merchandise in military or school stores.

4) Anticipation, Wanting, Liking

The **tongue-in-cheek** explanation of how "wanting" and "liking" can work together:

> When you learned to use your computer, you most probably were shaped to your final end-user status, either using positive reinforcement from one success to the next (Mac) or through the compulsion of learning what needs to be done to avoid the impending failures (Windows). In any case, you first learned how to turn on the computer. At first this was probably exciting, because you didn't really know what to expect. But when you learned that, you learned about programs and files and folders and finally the big day came and you first started Word (or similar word processing program).
>
> At one point, starting the computer didn't hold the fear of the unknown anymore, but rather the anticipation of getting on with it to starting Word and ... writing the next great .. letter to your friend. And spelling checking it and finally, since your friend is nowhere near as technology savvy as you, printing it out to take it to be snail-mailed. If you used a Mac, you slid from one easy success to the next, but if you used a Windows computer, you had to learn what happens if the computer doesn't start (F8 start and make sure the startup volume is defined, perhaps starting in safe mode), but maybe you were lucky today and the computer started, so you could start your Word program without any hassle. Finding that is no problem, but do you remember where you saved the last version of that letter to your friend? Panic until you actually DO find it. Great, so, now to just finish that last paragraph and hope the program doesn't crash like it did last night. The tension is rising, so you don't dare take a break for a beer to sooth your parched throat and dry mouth. You're on a roll and now all you have to do is save it again (NEVER, EVER do anything else after any process in Word without saving first and then going on to do something else). All you have to do is give the "print" command and ... reinstall the printer, because Word tells you there is no printer attached. When you finally have that letter in your hand, you can issue a huge sigh of relief ... you've done it, mission accomplished and you can now enjoy that well earned beer. And maybe even mail your friend his letter.
>
> You've just been guided through the climbing ever higher spiraling levels of anticipation in the process of writing a letter ("wanting") and culminating in the satisfaction of the enjoyment of admiring your work in your hand as it comes out of the printer ("liking").
>
> Some computer software and hardware manufacturers know how to capitalize on this process, and therefore seem to build uncertainty and adventure into their Windows PCs. Frankly, this explains why Microsoft Windows computers enjoy a 10 to 1 numerical advantage over their closest rival, Apple Macintosh. Windows computers are exciting, like Forrest Gump's box of chocolates, you never know what you're gonna get. The Macs just work, which is utterly boring. They get the job done with no excitement built in.

In our tongue-in-cheek version, we see how exciting the anticipation of something (finally) good happening can be. O'Doherty et al (2002) conducted an experiment to determine whether dopamine is released as an indication of enjoyment or as an indication of coming enjoyment, i.e., anticipation of that enjoyment. They wrote:

The aim of this study was to determine the brain regions involved in anticipation of a primary taste reward and to compare these regions to those responding to the receipt of a taste reward. Using fMRI, we scanned human subjects who were presented with visual cues that signaled subsequent reinforcement with a pleasant sweet taste (1 M glucose), a moderately unpleasant salt taste (0.2 M saline), or a neutral taste. Expectation of a pleasant taste produced activation in dopaminergic midbrain, posterior dorsal amygdala, striatum, and orbitofrontal cortex (OFC). Apart from OFC, these regions were not activated by reward receipt. The findings indicate that when rewards are predictable, brain regions recruited during expectation are, in part, dissociable from areas responding to reward receipt.

In his incredible book "Why Zebras Don't Get Cancer" (2004) as well as in his various lectures on the Uniqueness of Humans[23] Sapolsky describes the work done by Wolfram Schultz and his team[24][25] while at the University of Lausanne, Switzerland. Sapolsky explained, that this experiment disproved the idea that dopamine has to do with the reward, but that it has more to do with the **anticipation** of the reward. *This monkey has been trained, that when the little light comes on, it's one of those sessions where I can now get food, and it knows, that if I press this lever 10 times, after a little bit of a delay, if I press the lever 10 more times, I'll get some more food. It understands the task. What do we have here? We have first a signal, the light coming on saying "it's one of those sessions". ...*"*and what everyone initially thought was, dopamine would go up after the reward. It goes up when the signal comes on.*

He goes on to say that if the monkey, who has learned the task perfectly, then fulfills the task but only gets the reward once every two sessions, or only 50% of the criteria (one 10 lever push session with no reward, then one 10 lever push session with reward), the dopamine level increases by 3-fold of what it had been when the light last went on. Sapolsky says that this marks the introduction of the word "maybe" into the situational equation (maybe I'll get it this time, ...) increases the dopamine flow which indicates the increased anticipation of being able to do the task to get the reward. In the 50% "maybe" ratio more dopamine was produced in comparison to scenarios where the monkey got the reward in 3 out of 4 sessions (75%) or where the monkey only got fed in 1 out of 4 sessions (25%), BUT these levels of dopamine were still higher, than when the monkey got fed after each session. **Anticipation + unpredictability = more dopamine**. At 3'55" in the linked video, Sapolsky also speaks about delaying of the reward-giving even further, for example in humans until after death and showed a painting of St. Sebastian on the cross, full of arrows, awaiting being called up into heaven. So this infers that a delay between the signal (conditioned reinforcer) and the delivery of the paired or generalized reinforcer will also heighten the anticipation. We'll get into that later.

Wise (2004) writes similarly about what role dopamine plays in **The dopamine theory of conditioned reinforcement**: *Therefore, dopamine can modulate the expression of conditioned reinforcement as well as being essential for the establishment of conditioned reinforcers. It is the dopamine-dependent reinforcement history that establishes the conditioned reinforcer in the first place, and it is presumably the ability of the conditioned reinforcer, once established, to cause phasic dopamine release [61,62] that augments its momentary effectiveness.*

Kent Berridge and his team have been researching how dopamine is released and what its functions are. Wise (2000) summarisation is: *Wanting versus liking. Berridge and Robinson[99,134,135] have used the terms '**liking**' and '**wanting**' (bold emphasis LCecil) to distinguish two seemingly independent dimensions of reward function. ... This would identify **wanting** as the state of mind of an animal before receiving a reward, and **liking** with the state of mind of an animal after receiving that reward. However, Berridge and Robinson argue that **wanting** and **liking** are states of mind that can both be present before receipt of reward and that can, therefore, concurrently influence reward seeking. ... Berridge and Robinson argue that although dopamine is not important in the **liking** of reward (see anhedonia, above), it is important for the **wanting** of reward[134], or, in other words, for hunger or appetite.*

Applied to the Schultz groups[26] experiment and the reports by Wise (2004), it becomes apparent, that the conditioned reinforcer or cue instigate this "wanting" system which had been installed through the "liking" because of the pairing with the unconditioned reinforcer. This also shows how potent the conditioned reinforcer ("wanting") can be, being sufficient to continually drive the behavior without the presence of the unconditioned reinforcer ("liking"). Or in plain English: If the conditioned reinforcer is sufficiently paired to the unconditioned reinforcers (or even to other conditioned reinforcers) you may even heighten the behavioral response, not dampen it by NOT

23 https://www.youtube.com/watch?v=axrywDP9Ii0
24 Waelti et al (2001)
25 Fiorillo et al (2003)
26 ditto

delivering the primary reinforcer everytime – as Karen Pryor indicated (see above). And since there is only one possible behavior, there is no chance of Matching Law getting in the way, which only plays a role if there are two distinct and previously reinforced target behaviors, which are in competition with each other. This of course also explains why reinforcement schedules work so well, as we've seen in that observation made by Karen Pryor. THAT they work well, was shown by Kelleher (1957) and all those "Token Economy" people; the **wanting** and **liking** systems as shown by Schultz, Berridge Robinson, Wise and many others including our own Dr Simon Gadbois and Reeve (2014), which control the release of dopamine have shown the physiological and neurochemical "how".

If now the question has been answered, whether we must always feed after the click or risk devaluing the potency of the clicker (no, we don't have to), the next question that arises and is a bone of contention: How long may we actually wait between giving a secondary reinforcer and the following primary reinforcer IF we do decide to use a fixed ratio of 1:1 (CRF or FR1)? Which then leads to the question whether the click in this case, always serves as the end-of-behavior signal. Karen Pryor[27] writes that since the click itself is an event marker, one can identify a behavior in the middle of an action and wait until that action is finished to present the food. But how long is too long? On the one hand we have our different intermittent schedules of reinforcement and the idea that one does not need to follow each secondary reinforcer with a primary. So this creates in and of itself a "hole" which lasts at least until the next cue-behavior-reinforcer sequence starts. Pryor reported on an experiment done by Dr. Jesus Rosales-Ruiz[28] in which sheep had been trained to touch a target, be clicked and receive their food. But they then inserted a 5-second delay between the click and the food and the sheep started displaying displacement behaviors of pawing the ground, indicating that the sheep were in "conflict". They reported that if the delay is reduced to 2 seconds, the displacement behavior stops. When the delay is increased again, the displacement behavior also returns. My question: How was this delay introduced? How do they explain how intermittent schedules of reinforcers work?

This points to one small danger to be aware of, when using intermittent schedules of reinforcement: a possible decay of response performance due to introducing these too quickly and in an unprepared manner. For in terms of the comparison with a CRF, no matter what intermittent schedule you use, superficially, it may be perceived by the animal as a delay or simply leaving out of an expected reward – something that using CRF schedules does not prepare them for. Lattal (1974) writes that there are two kinds of delayed reinforcements. One is a **signaled delay** and the other is an **unsignaled delay**. He writes, that it is the **unsignaled delay** that is responsible for decay in response. He credits Ferster & Skinner[29] for making these distinctions. Richards (1981) confirmed this in direct comparisons between **signaled** and **unsignaled delay**. One hypothesis about the origin of these distinctions was set forth by Daly (1974), who found that an unexpected withdrawal of reinforcement (for example negative punishment or unsignaled delay of reinforcement – LCecil) may elicit a sense of frustration that can be quite aversive and lead the subjects to engage in displacement behaviors. This might also explain why it is so effective, when withdrawal of the expected reward is used as punishment,. It becomes clear that when switching from a continuous schedule of reinforcement (CRF) to an intermittent schedule, one should be diligent in not making the switch too abrupt, in other words: one should teach the animal that the rules have changed.

Wolfe, Crowle, Zimmerman and Kelleher all described a careful and relatively long training period for their subjects. They were able to **gradually** raise the amounts of secondary reinforcers without associated primary reinforcers going up to FR125 and more without the behaviors stopping. They didn't suddenly go from FR1 to FR125. Switching schedules was a **gradual** process in which the animals learned that the rules changed, step by step. Starting with primary after one repetition of the

27 http://www.clickertraining.com/node/65
28 ditto
29 Schedules of Reinforcement, New York, Appleton-Century-Crofts [©1957]

behavior and one secondary reinforcer, going slowly towards schedules with a higher ratio. Giving 10 repetitions of the same behavior became the anticipated norm, as in Schultz's experiment, explained by Sapolsky. And once again, Karen Pryor herself wrote (1985) concerning a keep going marker, that it means to keep doing what you're doing, the food is eventually going to come (see above). So we come back circularly, whether the clicker has some other properties, than other secondary reinforcers, like the keep-going secondary reinforcers have. It's my theory, that it depends how you introduce this possibility of a delay in the delivery of the primary reinforcer. If you introduce this as slowly and carefully as Wolfe, Crowle, Zimmerman and Kelleher did, one can use intermittent schedules of reinforcement with secondary reinforcers, as well as do so with a clicker. And if you so desire, you can increase some behaviors dependent upon time length, by delaying the delivery of the primary after signaling he correct behavior with the secondary. By doing so, you are using that relationship between the "wanting" and the "liking" mentioned above.

One answer to this quandary is found in the application of fixed interval or fixed time schedules as described in Lattal (2010) who uses the term "fixed time", but others (see above) use the term "fixed interval". An example of this would be, to intentionally "mark" a behavior with a secondary reinforcer and deliver the primary (or another secondary) reinforcer after 2 seconds, which is a FI2 schedule. This uses that "wanting" response to best advantage. When the behavior is well established under this criteria, simply raise the fixed interval to 3 seconds, then 4. If you had been delivering the primary immediately after the click in the beginning, you are now what we call in the training world: "fading the clicker, fading the food". What you may have progressing towards the end is a behavior that is repeated on a schedule of FI20, but is actually over the first time after 16 seconds. This gives you 4 seconds after the behavior is finished to actually deliver a primary reinforcer, if you wish. I would.

5) What does all this mean for me?

Up until now, the golden rule of clicker training as been “one click, one treat” with the passed on corollary of “the primary reinforcer must follow the behavior by no more than 2 seconds”. Anyone who has done any dog training will now raise their hands and ask “But what about....?” And the questions will pour in. Unfortunately, the answers come more from a very narrow knowledge set and adhere also to something related to what is called “Corporate Identity” (CI). Generally speaking, corporate identity is a type of merchandizing of a product. Everything that has to do with this product must conform to specific expectations set up the “guidelines” that help define this product to the customers. This includes the same logo everywhere, the same color combinations, same typefaces, a company philosophy etc.

We have certain labels in the the dog world that bring certain expectations. Cesar Millan, Karen Pryor, Captain Haggerty, Ian Dunbar. These are not just people, they are industries with their own corporate identities. You don’t just buy a book, you buy a CI, that guarantees a certain philosophy, and fulfills certain expectations. When we say that we are “positive trainers” or “Force Free trainers” or “Clicker Trainers”, we have bought and paid for this corporate identity and identify with it. That’s fine as far as it goes, but ... each one of these represents a box with very specific contents which may or may not include aspects of other boxes’ contents, and also exclude anything considered to be incompatible with it’s own CI. Many people will then be identified by their appearances with a certain CI, either through training traits or simple equipment. These CIs all have their own rules. So if someone has a clicker and uses it differently than a Clicker Trainer, **he’s doing it WRONG!!!** This is what happened to Dr. Gadbois. He violated the CI of Clicker Training and it’s “rules”. **He’s doing it WRONG**. And interestingly, many people stop asking at that point, about the “why” or about any results. They stop asking about exactly what it is, that this person is doing. It doesn’t fit the cut-out, so ... **He’s doing it WRONG**.

What I’m going to write below is based upon

1) what some of us have learned is “right”
2) and supporting science shown above, showing that what is “right” is not necessarily the only “right”.

If you are satisfied with your knowledge set, you may not want to read further, for it may upset you. Some of it is based upon things said by Karen Pryor herself, some of it is an expansion upon that, either through inference or through scientific evidence. Some of it will seem to contradict what “we” have learned with the clicker in our hands. But some of it may lead to new ideas or explain not so new ones that somehow have not made it into the “handbook”.

What I will NOT do, is tell you what to do. Do as you wish. I am only making suggestions below – and some people will call it quits right now. If so, thanks for reading this far!

5.1 When to use the clicker:

Whenever you want, but as suggested by Karen Pryor (1985): use it to **teach** behaviors. But after the behavior has been taught, fade it out as she suggests. It’s a training tool used to teach behaviors in the acquisition phase. You don’t drive your car with the instruction manual open on the front seat next to you, so you may want to stop using a clicker after your dog has learned the behavior. No one is saying you are not allowed to say “good dog”, which will take all of about 2 minutes to condition as a new conditioned reinforcer. It’s a nice thing to say to your dog. And I’m definitely NOT saying you MUST stop using the clicker after the acquisition phase. I have no CI to sell.

5.2 You might also want to fade out the food treats.

Since we know that secondary reinforcers can be every bit as reinforcing as primary ones, you might want to consider using some of those environmental reinforcers. Or just "good dog". Or both. Or more. Or none. And if you think you're losing behavior performance, throw in a couple of clicks now and again, maybe even a C/T or just the treat.

5.3 Use those "keep going" secondary reinforcers!

Once conditioned, they are golden. If you look at them closely, they are more likely either Variable Ratio or Variable Interval Reinforcement Schedules. Think about that, because they are based upon the resilience of the association to the primary reinforcer. A tip from my own experience – don't sneak them up at full strength on your dog. Think of shaping and introduce them one ratio increment at a time. As Wolfe, Crowle, Zimmerman and Kelleher (see above) did.

5.4 An example of using secondary reinforcers in fixed ratio and fixed interval schedules:

That obedience loving stare-in-your-eyes "heel". Why not start with a one-step equals CRF/FR1. One step → click → reinforce → repeat. Now, up the ante. Two steps → click → primary → repeat (FR2). And now comes the fun ... after a few days of this, try a two-step → click-two-step → click/primary. This is going back to Sapolskys/Schultz' monkeys. You've actually introduced a FR2 with the clicker over an FR4 with the food. Combined running schedules of reinforcement[30]. Your dog will look at you with a WTF look, but will keep going with the attitude, "I got the click, why not the food?". Now you can start adding steps. First 3/6 (click to food). And ... unpredictability keeps this "wanting" dopamine flowing: going back to a 2/4. then up it again to a 3/9. If your dog seems to lose interest, you're upping the ante too fast.

Now, you can put your clicker away and condition the march-off **cue** "heel" to **also** be a **secondary reinforcer** (which if you think about it, DOES reinforce the looking up at you – the start of the behavior chain) and just to be sure, start the overlapping combined reinforcement schedules[31] again. Condition the "looking up into your eyes" with a marker "heel" – capture it and feed at the dog's feet, so she breaks eye contact to get the food, capture look/marker "heel" reinforce ... repeat.

You'll see, that your dog's attention will be just as good as with the clicker. Add a couple of steps: "Heel" → step → step → "heel" → step → step → "heel" → step → step → food (primary reinforcer). Just like Jean Donaldson's tactic above. The basis upon how this works and works well is the fact, that the secondary reinforcer is as resilient as the primary reinforcer for many, many repetitions and your dog will show you, when you've gone too far too fast. In the end, you've standing next to the judge. You know you have to march 20 paces, turn left for 6, return for 20 paces – and it looks like:

"heel" (secondary reinforcer) → step → step → step → step → .... step → stop

At that point it is generally allowed to "reward your dog" which you can with praise, get her over to the side and feed her her well earned primary reinforcer. You've just added a FI120 (fixed interval 1:120 seconds) in terms of secondary "heel" to primary "treats" on the side.
Now ... was that so radical? It's most probably something you've been doing anyway, just not with that clicker or "heel" as secondary reinforcer for the "look deep into my eyes" start in the beginning. And not thinking about the science behind it.

30 http://www.educateautism.com/applied-behaviour-analysis/schedules-of-reinforcement.html
31 ditto

Examples of possible combined reinforcement schedules:

1) Fixed Ratio schedules, fading out secondary reinforcer.

C = clicker sound
M = marker word C/M = either or

cue
"heel" M C M M M C/M

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1°

FR3 = reinforcer every 3 steps

FR18 = reinforcer every 18 steps

"heel" has been conditioned -from- being a cue -to- being a secondary reinforcer for ... looking up at handler and step-off. C or M are interchangeable

1° = primary reinforcer OR high value secondary reinforcer (ex. ball or stick...)

cue
"heel" M M M C/M

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1°

FR5/FR3 = reinforcer every 5/3 steps

FR18 = reinforcer every 18 steps

cue
"heel" M M C/M

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1°

FR6 = reinforcer every 6 steps

FR18 = reinforcer every 18 steps

cue
"heel" M C/M

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1°

FR9 = reinforcer every 9 steps

FR18 = reinforcer every 18 steps

cue
"heel"

C/M

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1°

FR18 = reinforcer every 18 steps

FR18 = reinforcer every 18 steps

2) Variable Ratio Schedule

cue
"heel" M M M M C M C/M

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
1°

VR3 = reinforcer mean average = 3

FR18 = reinforcer every 18 steps

5.5 Using a straight FI or even VI to train a "sit-stay":

Here are a couple of things to chew on for a minute:

1) To click and not immediately treat is not necessarily a delay of reinforcement, it's a timed intervalic delivery of the two reinforcers.
2) A "sit-stay" IS two behaviors: "sit" and "stay" – don't forget what Karen Pryor wrote and what science has confirmed over and over – secondary reinforcers can be just as reinforcing as primary reinforcers! Keeping those two points in mind, let's see what can be done using **F**ixed **I**nterval Reinforcement Schedules to train a "sit-stay":

   Cue a "sit" → click → treat .. repeat many times. (CRF)
   Cue a "sit" → click → wait exactly 1 second → treat (actually for the stay) .. repeat many times. (FI1)
   Cue a "sit" → click → wait exactly 2 seconds → treat (actually for the stay) .. repeat many times. (FI2)
   Cue a "sit" → click → wait exactly 3 seconds → treat (actually for the stay) .. repeat many times. (FI3)
   and so on.

Now ... fade the clicker, fade the food

This is nothing more than an **alternate** suggestion to the **standard** method of:
Cue a "sit", wait 1-x second(s = "stay") and C/T to signal the end of the stay.

Since the interval is gradually increased, you're still within that "wanting" dopamine flow during the time between the click for the "sit" and the primary reinforcer with "liking" for the stay. You're using two combined overlapping **F**ixed **I**nterval Reinforcement Schedules:

FI1 for the click and
FI10 (10 seconds or whatever your time goal is for stay) for the endpoint of the sit (=stay).

And to keep it even more interesting for the dog, you might even want to try a Variable Interval Schedule of, say .... 15 (VI15), meaning changing the interval from somewhere between 2 seconds to 20 seconds resulting in an average mean interval of 15 seconds for the further repetitions.

6) Conclusion

The intention of this paper is NOT to prove that anyone has been **doing it wrong**. I'll leave that to those who will take that approach. The purpose is to show, that within the realms of empirical scientific data, there is no reason NOT to leave out the primary reinforcer after the secondary reinforcer once the association between the two has been firmly established. We do this already in the case of "keep going signals". The most important thing is: **when you deliver a primary reinforcer after a secondary, know why you elect do so and why you elect not to do so**.
So to summarize:

You are using a couple key ideas:

1) All secondary reinforcers are created equal. Clickers are not equal-er.
2) There is no scientific law stating you must follow a secondary reinforcer with a primary reinforcer meaning.
3) Secondary reinforcers can be as appetitive (reinforcing) as primary reinforcers or more.
4) Therefore, there is no reason why you cannot follow a secondary reinforcer with another secondary reinforcer, as long as it really IS reinforcing in character.
5) You are using the "wanting" system to its full advantage, which generally makes it that more interesting and therefore more motivating for the dog.

Therefore:

1) You are not obligated to always follow that secondary immediately with a primary reinforcer. You don't do so with "keep going" secondary reinforcers. You don't do that with "non-clicker" secondary reinforcers like "good dog". And mostly ... if you still WANT to always follow that click with a treat, please do so. You now are free of the pressure do it because some expert said **You're doing it WRONG** if you don't. It's now your choice, not your duty.
2) As long as the association between the secondary and primary reinforcers is well established, for example with that "keep going signal", there is no reason why a primary must always follow a secondary reinforcer. This has been shown empirically and known to science for almost 80 years. The neurological underpinnings have been known since the 90's. (see above)
3) The clicker is not a special sort of secondary reinforcer. It is, like all secondary reinforcers, firmly associated with the primary reinforcer – or even several primary reinforcers or secondary reinforcers if that first secondary reinforcer is a **conditioned generalize reinforcer**[32]. It is held to the same "laws" that all secondary reinforcers are. That means there is no problem with leaving out the primary now and again, once that association is firmly established.
4) The amount of times one can withhold the primary reinforcer will depend upon many factors, such as the original strength of the association to the primary, the situational valance, the relationship one has to the animal, interruptions in training flow and perhaps the manner in which the idea of switching from a CRF to an intermittent reinforcement schedule is introduced, i.e., **gradually**. In the first experiments, great care was given to be sure that the animals understood the task, introduced with a CRF and then to slowly increased variances. It would be a good idea to follow that example.

32 http://www.scienceofbehavior.com/lms/mod/glossary/view.php

5) It may seem as though there were incongruities in the science – however, each study is the result of asking a specific question and setting up mechanisms to test that specific question, without necessarily taking into consideration the questions and findings of others, but if so, only where directly relevant to the posed question/hypothesis. The much mentioned Matching Law does NOT disprove schedules of reinforcement. It was designed to investigate situations in which a subject can actively choose between two known, learned and present behaviors. This is not what schedules of reinforcement are all about. The tests for efficiency of training in which delay between secondary reinforcer and primary reinforcer also do not contradict schedules of reinforcement, because the introduction of the delay was always tested after a CRF or as opposed to a CRF but not as opposed to a "shaped" **gradually** progressing schedules of variable or fixed intervals. In other words, the introduction of the delay was unprepared and was the probable cause for the displacement behaviors; when the delay is **gradually** introduced, as one does when introducing reinforcement schedules, this will not happen, if done **gradually** enough.
6) The subject of different schedules of reinforcement is hardly mentioned amongst dog trainers. While it's been empirically shown to be more efficient and with better efficacy than CRF, the subject of when and how to implement these has often been grossly ignored. So if this paper does nothing else, I'm hoping it will show you that implementing reinforcement schedules now and again after the acquisition phase of learning (my recommendation – there is conflicting empirical data that shows that they may or may not work even during the acquisition phase) for certain types of behaviors will neither ruin your clicker nor your dog. When asked "When is the best time to use these reinforcement schedules?", I'd have to reply, that as shown in sections **5.4** and **5.5** above, reinforcement schedules are very appropriate for types of behaviors that are carried out over a period of time or a certain distance. They can also be applied to behaviors repeated in a chain. They are probably not as effective for one-off behaviors.

Judge: Members of the jury, please state your verdict in the case of the "people" vs all who do not always follow the click with a treat.

Jury Foreperson: If it please the court, the jury finds, due to the extensive amount of scientific evidence presented by the defense, (dramatic pause) for the defense. The defendants may continue to either give a treat after a click or not as they choose.

Much thanks to Sunny for reading and offering great suggestions for the betterment of the paper.

Sunny Benett, akademisch geprüfte Kynologin, Universität Wien (Austria)

She showed me very clearly, how 40 years living in Switzerland has ruined my English.

Happy Training!

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8) Addenda

Other papers of possible interest:

1) **Literature Review: "But I thought....."** – Some thoughts on dog trainers' myths, where necessary with either direct quotes from studies and/or links to the originals. Mostly concerning the existence of "Return of Fear" as well as what the "literature" really says about one of our favorite terms "Threshold" (It can't be that there we use so many different definitions – there must be some standard ones already in existence). http://www.auf-den-hund-gekommen.net/-/paper1.html

2) **Is Learning Theory Enough?** – There are so many -ologies and -isms out there. Is the so-called "Learning Theory" really all we need. Of COURSE we look at breeds and that's Ethology, but what else could we be taking into consideration beside operant conditioning, respondent conditioning, ABC contingencies and quadrants? http://www.auf-den-hund-gekommen.net/-/paper2.html

3) **Drive: Where it came from. Where it's gone to. What now?** – Frankly, I'd never considered "drive", never had any use for it, wasn't covered in my basic training. Was that a BIG mistake? Doesn't everyone KNOW all about "drive"? The learning experience began for me, when I started learning IPO/Schutzhund/VPG. EVERYTHING is "drive" and my dog, according to "experts", didn't have any. My off-the-wall Flat? No "drive"? So I decided to do what I do. Question. And came up with interesting answers. I then looked at how "the experts" actually use the term. Ohhhhh boy. http://www.auf-den-hund-gekommen.net/-/paper3.html

4) **What if I told you... ? ... that just maybe not all of what we "science-based trainers" do or call is so "science-based" after all**. That's a BIG supposition, so I'd better have some proof to back me up. Well, for some of the most common vocabulary in canine behavior modification, having to to with fear and aggression treatments, I went back to the source, ie psychology glossaries and texts and looked up the various definitions and approach descriptions (hint - you thought there was always only one standard in psychology?) and either quoted them and/or linked to them. Then because science is NOT standing still, but is moving beneath our feet, I looked at some of the newer developments that could be game changers and .... linked to the evidence-based studies, reviews of studies, etc.http://www.auf-den-hund-gekommen.net/-/paper4.html