LOST CABIN CONSULTING

GAMING MATHEMATICS & PRODUCT INTELLIGENCE

DEEP DIVE SLOT INTELLIGENCE SERIES · PERCEIVED PROGRESSION

Perceived Progression

Pots that fill, bags that swell and firecrackers that flicker: what the display stores, what the math engine reads, why a full pot is exactly as far from the feature as an empty one, why players chase it anyway, and what the regulators actually require

By **Robert Adam Clifford**

ABOUT THIS DEEP DIVE. A companion to the Slot Intelligence Series. Every volume's Appendix C sorts the displays that seem to build toward an award into decoration, elapsed-play record and true persistent state. This deep dive sets out the standard behind those calls: where the display came from, the probability that governs it, a model machine run for twenty million spins with its code printed, the psychology of the chase, and the rules a regulator applies. Every source is named where it is used and graded by tier.

Subject	Perceived progression (the trade's "perceived persistence" and "pseudo persistence") against true persistence, on video and mechanical-reel slots
Primary Sources	U.S. Patent 4,448,419 (Telnaes, 1984) T1; U.S. Patent 12,424,053 B2 (Aristocrat, 2025) T1; Nevada Gaming Commission Regulation 14 (August 2026 text) and Technical Standard 1 (February 26, 2026) T1; GLI-11, Version 3.0 T1; makers' help screens as quoted in Volumes II and IX T1
Research	Hull (1932); Zeigarnik (1927) and Ovsiankina (1928) with the 2025 meta-analysis of both; Ferster and Skinner (1957); Tversky and Kahneman (1971); Kivetz, Urminsky and Zheng (2006); Dixon and colleagues (2010)
Model	Two model machines, 10,000,000 spins each, one with a pot and one with a must-hit-by counter; the Python is printed in full and its output is the output of that code
Series	The perceived-progression rulings of Volumes I to XXIV, gathered in Table 1.2
Prepared By	Robert Adam Clifford · Lost Cabin Consulting · October 2026

1 in 120
FEATURE RATE WITH THE MODEL'S POT FULL (118 EMPTY)

120
AVERAGE SPINS TO THE FEATURE FROM ANY POT LEVEL

0
CHANGE IN RETURN FROM ONE POT LEVEL TO THE NEXT

1.600(9)
NEVADA'S 2026 BAR ON "DUE" AND "OVERDUE" LANGUAGE

SUMMARY

Perceived progression is a display that looks like progress toward an award and is not. A pot fills with coins, a bag swells, a string of firecrackers flickers harder, a character stirs. Each looks like a gauge running toward a feature. On a perceived-progression game the feature is drawn fresh on every spin at the same probability, and the display only reports what has already landed. A full pot is exactly as far from paying as an empty one. True persistence is the opposite case: the machine stores a count, bank or meter that the math engine reads, so the odds or the value of what comes next really do change. The difference is not whether the display is saved. It is whether the outcome reads it.

The math is one line. When each spin's trigger comes from a fresh random draw, the chance of a feature on the next spin given any run of misses is the base probability, $P(F_{n+1} \mid F_1^{c} \cap \ldots \cap F_n^{c}) = P(F)$, and so the return is the same at every visual state. The model machine in Section 3 bears it out over 10,000,000 spins: a 1-in-120 feature fired at 1 in 118.4 with the pot empty and 1 in 120.1 with it full, the return ran 88.24% to 89.09% against an exact 88.53%, and the average wait to the next feature was 119 to 121 spins at every level, while the time since the last one ran from 21 spins at level 1 to 203 at level 5. The pot measures the past. It says nothing about the future.

The display became possible in 1984. Inge Telnaes's patent let a random number pick the reel stop from a table larger than the strip, so the odds no longer had to match what the reel could physically show. Once outcome and display were separate, the display could be built for engagement. The multi-pot video games of the last decade are that idea at full scale, and the makers name it themselves: Light & Wonder sells "perceived persistence," AGS "Pseudo persistence," and Aristocrat's 2025 patent draws the feature "independent of the graphical state" of its filling indicators.

The pull is real; the research behind it is uneven. Hull's goal gradient (effort speeds up near a goal) and Kivetz's coffee-card study of illusory progress are solid. The Zeigarnik memory effect is not: a 2025 meta-analysis found it does not hold generally, while the related urge to resume an interrupted task does. The slot's feature runs on a random-ratio schedule, the constant-chance form of Skinner's variable ratio, and the pot dresses it as a schedule that pays at the end. The gambler's fallacy, sunk cost and losses disguised as wins complete the picture. No controlled study found for this deep dive isolates a filling pot and measures its effect on play.

No regulation requires a pot disclaimer. Nevada's Regulation 14 and GLI-11 require that rules, artwork and help screens be accurate and not misleading, that every outcome be available on every play, and that a true persistence game describe its thresholds in its help. Since February 26, 2026, Nevada's Technical Standard 1.600(9) also bars any language suggesting an outcome is more likely than it is, naming "Due," "Overdue" and "Ready to Hit." The disclaimers players see on pots ("for presentation only," "no effect on triggering") are the makers' own sentences, not text a regulator prescribes.

1 — PERCEIVED PROGRESSION AND TRUE PERSISTENCE

1.1 Two Architectures That Look Alike

Perceived progression is a display layer whose assets grow, fill or change as play goes on, giving the impression that a feature or award is near, while the probability of the outcome on every wager stays the same. The trade calls it **perceived persistence** (Light & Wonder's term) or **pseudo persistence** (AGS's). **True persistence** is a stored game state that the math engine reads: a count of symbols collected, a bank of wilds, a hidden hit point, a meter. GLI-11, the laboratory standard most regulators adopt, defines the persistence game as one that "incorporates a feature that enables progress" toward bonuses or enhancements, where "Each designated outcome advances the state of the persistence game" and "Multiple plays of a game are usually necessary to trigger the persistence award" (GLI-11 v3.0, §4.21.1) **T1**.

The series sorts every display into three classes on one standard. **Decoration** stores nothing that matters. An **elapsed-play record** stores only how long it has been since the last award: a pot that fills with play and empties at the feature is a clock, and it reads how long, never how soon. **True persistent state** changes the odds or the value of what is still to come. The first two are perceived progression. The third is the only one with a price.

Table 1.1 — Perceived progression against true persistence

DIMENSION	PERCEIVED PROGRESSION (PSEUDO-PERSISTENCE)	TRUE PERSISTENCE (ACTUAL PROGRESSION)
State storage	Often stored, and kept across players and cash-outs; the trade's "persistence" can mean only that the art stays. Storage is not the test: whether the outcome reads it is.	Stored in the machine's nonvolatile memory or a persistence controller, by bet level, device or player account (GLI-11 §4.21).
Probability impact	$P(F \mid S_v = s) = P(F)$ for every visual state s. A fresh draw decides every spin.	$P(F \mid \text{state})$ rises with the state, or the state sets the bonus value. A must-hit-by counter in this deep dive's model runs from 1 in 208.5 early to 1 in 30.3 late.
Value impact	None: the return at every visual state is the machine's return ($\partial \text{RTP}/\partial S_v = 0$).	Real: expected value per spin rises as the state builds; Magic Treasures' numbered pot sets how many balls the bonus drops (Volume XX).
Primary driver	The look of progress; the engagement effect is the product.	Arithmetic: each collected token adds expected value to later spins.
What the rules say	A maker's own sentence, when it prints one: "for presentation only," "no effect on triggering."	Thresholds and restore rules in the help (required by GLI-11 §4.21.2); "MUST BE WON BEFORE 1888" (Volume XV).
Advantage-play risk	None. There is no edge in an "overdue" pot, and none is lost by walking away from a full one.	High where the state is bounded and visible: players hunt banks near must-hit-by and pots near the top (Volumes III, XIII, XV, XX).

The two perceived classes differ in what the display tracks, not in what it predicts. A decoration may fill at random or on a timer; an elapsed-play record fills with play and resets at the award, so it does show how long the machine has gone without one. Neither changes the next spin.

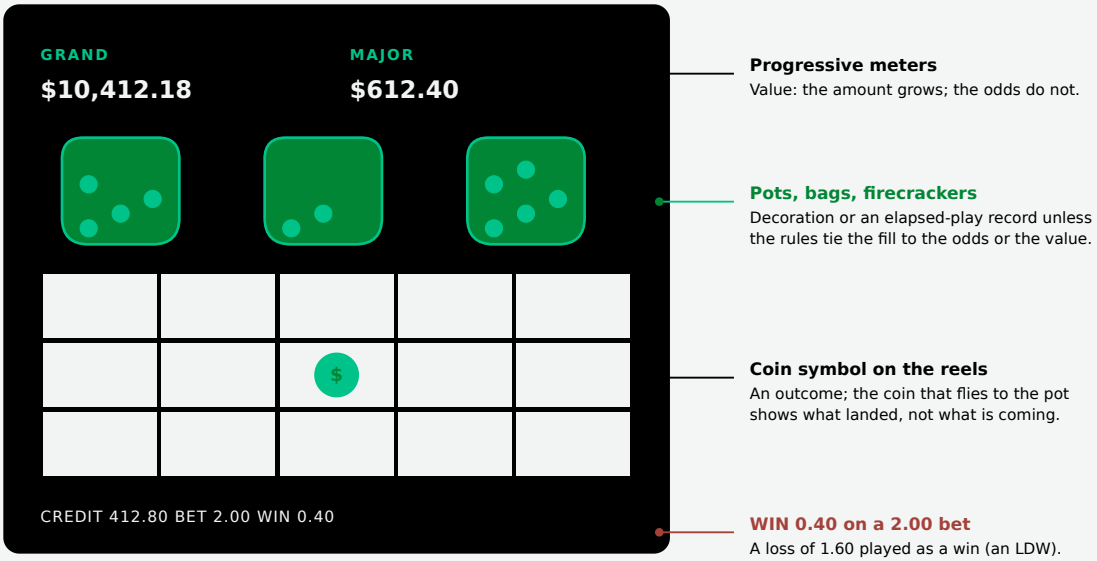


Figure 1 — The parts of a progression display. A schematic of a multi-pot video game's screen, not any maker's artwork. The meters carry value, the pots carry the look of progress, and the coin on the reels is an outcome already drawn. The win meter shows 0.40 on a 2.00 bet: a net loss of 1.60, presented as a win (Section 4.6).

1.2 The Words the Makers Use

The makers do not hide the mechanism; they sell it. Light & Wonder markets Big Hot Flaming Pots on "triple-pot perceived persistence," calls Huff N' Puff Hard Hat Edition's hat "a perceived persistence hard hat," and lists a "Perceived Persistent pot" on Ultimate Quick Hit Fire Link. AGS launched Rakin' Bacon Link at G2E 2024 with "Pseudo persistence" on the feature list (Volumes II, IV, VI and I) T1. Aristocrat uses the word "metamorphic" for its indicators, and its U.S. Patent 12,424,053 B2 (filed August 24, 2023, granted September 23, 2025; inventors John Ludwick and Christmas Uberuaga) describes how one behaves: each indicator can "advance to the next graphical state in the ordered sequence" as trigger symbols land, while the processor decides the feature "independent of the graphical state of the metamorphic indicator" T1. That sentence is the definition of perceived progression in a maker's own legal language.

The same word can point the other way. Aristocrat's trade copy for its 2021 Fu Dai Lian Lian Boost releases, as printed by Indian Gaming on March 5, 2021, describes "three metamorphic features with true persistence" and three bags, "prosperity, longevity, jackpot," that symbols on the reels fill T2. Boost Peacock's filmed help (Volume XXVII, C.9) prints benefits at a bag's highest state, no return figure, and a trigger still reading "THERE IS A CHANCE"; Boost Tiger's is unfilmed. In sales copy, "persistence" often means only that the art stays on the machine. It says nothing about odds until a help screen does.

Table 1.2 — The series' rulings: what the display shows, what the rules say, and the class

VOLUME · GAME (MAKER)	DISPLAY	WHAT THE RULES OR RECORD SAY	CLASS ON THE RECORD
II · Big Hot Flaming Pots (L&W)	Three pots and their fire	"The appearance of pots and fire over time is for presentation only" (help file)	Decoration
IX · Dancing Drums (L&W)	Coin pot, bowls, Link's three pots	"The accumulation of COINS over time in COIN POT has no effect on triggering the Jackpot Bonus"	Elapsed-play record: the archetype
VI · Quick Hit (L&W)	Ultimate Quick Hit Fire Link pot	"Perceived Persistent pot" (maker's catalog)	Decoration, by the maker's label
IV · Huff N' Puff (L&W)	Hard Hat Edition's hat	"a perceived persistence hard hat" (maker)	Decoration
I · Rakin' Bacon! (AGS)	The golden pig; Link's display	"Pseudo persistence" (AGS); the pig fills with play	Pig an elapsed-play record
VIII · Spooky Link (Aristocrat)	Gem pots	Patent: feature drawn "independent of the graphical state"	Elapsed-play record on the design record
III · Regal Riches (L&W)	A flame behind each wild bank	Banks must hit by 75, 100 and 125 wilds	Flame a record; banks true state
XIII · Phoenix Link (Aristocrat)	The Phoenix counter, with its ceiling	"mystery hit-by Phoenix Counter"	True persistent state, bounded
XV · Lightning 10 Year Storm	The Lightning Free meter	"MUST BE WON BEFORE 1888" (maker's screen)	True persistent state, bounded
XX · Magic Treasures Gold (IGT)	The numbered Money Ball pot, per bet	A higher number "increases the bonus chance" (social rules)	True persistent state
XXII · Ultimate Fire Link (L&W)	Cash Falls' held reels	Held "for the next 3 wagered spins" (maker)	True persistent state, three spins

Each row is the ruling of that volume's Appendix C, with the quotation that volume prints and grades; the full table, Volumes I to XXVII, is the series' Perceived Progression page. Bao Zhu Zhao Fu (Gimmie Games for Aristocrat, 2021; Volume XXVII) is the textbook elapsed-play record: its firecracker stacks climb on rockets, not time, so a stack tends to sit higher the longer a bonus stays away, which CDC Gaming's Buddy Frank called a myth if read as a bonus coming due (October 25, 2023) T2.

2 — FROM REEL GEOMETRY TO THE DECOUPLED DISPLAY

2.1 The Mechanical Constraint

On a mechanical slot the probability of a symbol was the share of the strip it occupied. Every stop was equally likely, so a three-reel machine with 20 stops a reel had $20^3 = 8{,}000$ outcomes, and its rarest combination could be no rarer than 1 in 8,000. Telnaes's patent states the limit directly: under the conventional approach, a three-reel machine of 20 stops has a lowest payoff probability of 1 in 8,000 T1. A 22-stop strip, the patent's own standard reel, raises it only to $22^3 = 10{,}648$. To make a top award rarer, a designer had to add stops, which made the reel larger, or reels, which the player would see. A large jackpot needs a rare combination, and the physical strip could not supply one.

The same geometry made the reel honest by construction. What the player saw on the strip was the probability. A symbol that appeared often on the glass appeared often on the payline. There was no separate presentation layer to fill, swell or flicker, and nothing on the cabinet could look like progress without being a mechanism.

2.2 The Telnaes Patent and the Virtual Reel

U.S. Patent 4,448,419, "Electronic gaming device utilizing a random number generator for selecting the reel stop positions," was filed by Inge S. Telnaes on February 24, 1982, and issued May 15, 1984; the patent office's assignment record shows it passing to International Game Technology in 1989 T1. Its abstract describes numbers assigned to the reel stopping positions, "with each number being entered one or more times to control the payout odds," which ends in the line that changed the industry: "enabling any odds to be set without changing the physical characteristics of the machine." A random number generator picks a number; a table maps the number to a stop; the reel is braked there.

The patent's worked example uses a 22-stop reel and a 44-entry table. Cherry occupies 2 of 22 physical stops, a probability of 0.0909; given 3 of the 44 entries it becomes 3/44 = 0.0682 (the patent prints "about .0681," the same figure cut at four places). Scaled up, the effect is large. With one entry of 64 for the top symbol on each of three 22-stop reels, the top line falls from 1 in 10,648 on the physical strips to 1 in $64^3 = 262{,}144$, about 24.6 times rarer, with nothing on the glass changed. Figure 2 draws that illustrative reel.

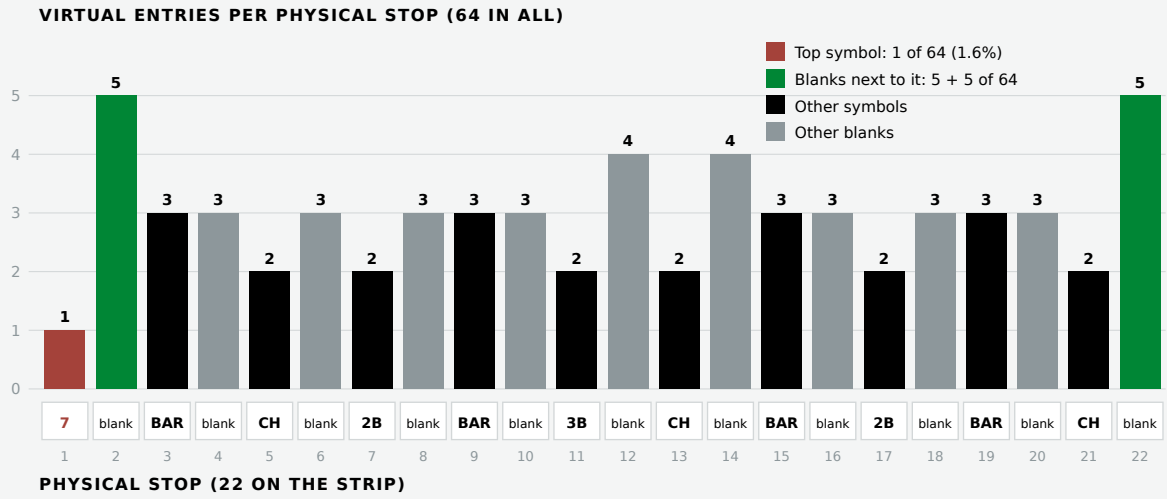


Figure 2 — An illustrative 64-entry virtual reel on a 22-stop strip. Bar heights are the entries mapped to each physical stop. The 7 has one entry, a 1.6% chance of stopping on the line, while the blanks on either side of it have five each, so the 7 rests just above or below the line ten times as often as on it. This is a teaching example, not any machine's table.

Figure 2 also shows the first case of a display that misleads by design without being false. Weighting the blanks next to a top symbol puts that symbol in view, just off the payline, far more often than it lands. Kevin Harrigan's 2008 paper in the *International Journal of Mental Health and Addiction* traces the technique and the 1989 ruling that drew the line: algorithms that put extra near misses on the payline were held unacceptable, while virtual-reel weighting that places them above and below it was allowed T2. GLI-11 now bars the other route, a game that picks a losing outcome and then shows a different, more tantalizing loss (§4.7.2(c)).

The Telnaes patent is sometimes cited as U.S. 4,448,625. That number belongs to a 1984 patent for a folding plastic chair mat. The virtual-reel patent is 4,448,419.

2.3 Video Screens and the Multi-Pot Game

Once the outcome was a table lookup, the reels themselves became presentation, and video removed the last physical tie. A video game's screen is drawn from the outcome after the math engine has decided it; any asset on it can be animated to tell any story that does not misstate the outcome. Through the 2010s and 2020s the major makers built that story around containers that fill:

Table 2.1 — From the virtual reel to the multi-pot game

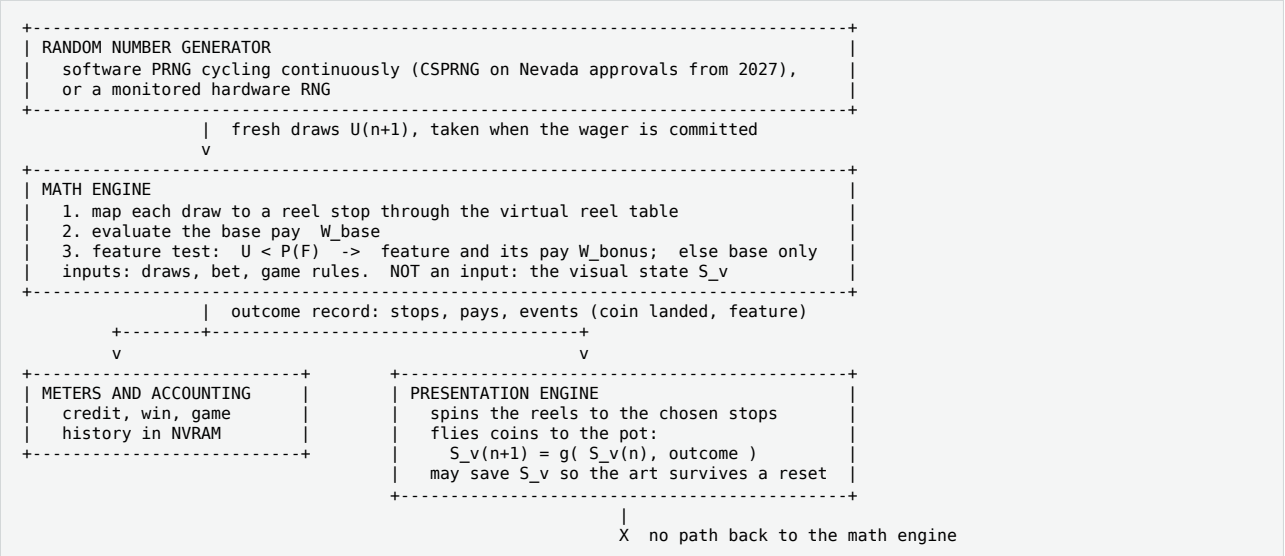
YEAR	EVENT	WHAT IT ESTABLISHED	TIER
1984	Telnaes, U.S. 4,448,419	The random number picks the stop; odds detach from the strip	T1
1989	Assignment to IGT; the near-miss ruling	Virtual reels become the industry's method; payline near misses ruled out (Harrigan)	T1
2016	GLI-11 Version 3.0	§4.21 defines persistence games and their help-screen duties	T1
2019	Aristocrat, Fu Dai Lian Lian	First family built for the MarsX cabinet; three bags tied to three features	T2
2021	Aristocrat (Gimmie Games), Bao Zhu Zhao Fu	Rockets may trigger the bonuses; firecracker stacks climb on some rockets, not with time (Volume XXVII)	T3
2023	Light & Wonder, Big Hot Flaming Pots	Three pots sold as "triple-pot perceived persistence"; "for presentation only"	T1
2024	AGS, Rakin' Bacon Link	"Pseudo persistence" on the launch feature list (G2E)	T1
2025	L&W Huff N' Puff Hard Hat; Aristocrat patent 12,424,053	"a perceived persistence hard hat"; the feature drawn "independent of the graphical state"	T1
2026	Nevada Technical Standard 1	1.600(9) bars "Due," "Overdue" and "Ready to Hit" language (February 26)	T1

Two cautions on the record. Ultimate Fire Link, sometimes listed among the multi-pot games, is a Light & Wonder hold-and-spin franchise whose own progress (rows that open at 8, 12, 16 and 20 held fireballs) lives inside a single feature; its pots belong to the Triple Nova title, labeled by its maker as "perceived persistence" (Volume XXII). And IGT's contribution to the genre is the counterexample: Magic Treasures' numbered Money Ball pot is real state, one per bet, and the help says a higher number "increases the bonus chance" (Volume XX). Not every pot is perceived progression. The rules decide.

3 — THE RNG, THE TRIGGER AND THE RETURN

3.1 Two Engines, One Direction

A modern machine runs the outcome and the picture as separate processes. The random number generator produces draws; the math engine turns them into reel stops, pays and feature decisions; the outcome record goes to the meters and to the presentation layer, which animates it. The presentation layer may keep its own state, the pot's fill level, and may save it so the screen comes back the same after a power cycle. Nothing flows back. In Nevada the random selection process must pass a chi-squared test at 95 percent confidence, a software RNG on a device approved before January 1, 2027 must cycle at an average of at least 100 times a second and may not draw values for future play, and a device approved on or after that date must use a cryptographically secure generator (Technical Standard 1.400) T1.



Aristocrat's 2025 patent states the same architecture in its own terms, an indicator advancing through "an ordered sequence of graphical states" while the feature is decided "independent of the graphical state" (Section 1.2). A design with true persistence differs at one place in the diagram: an arrow from stored state into step 3.

3.2 The Probability Equation

Let F_i be the event that spin i triggers the feature, F_i^C that it does not, and $p = P(F)$ the feature probability on any one wager. When each spin's trigger is decided by a draw independent of all earlier draws,

$$P(F_{n+1} \mid F_1^C \cap F_2^C \cap \cdots \cap F_n^C) = P(F) = p \tag{1}$$

because conditioning on an event that depends only on draws 1 to n cannot change the distribution of draw $n + 1$. Two consequences follow, and both are what the pot appears to contradict. The number of spins T to the next feature is

geometric, and its remaining wait is memoryless:

$$P(T > k) = (1 - p)^{k} \qquad E[T - n \mid T > n] = \frac{1}{p} \tag{2}$$

At p = 1/120, 36.63% of 120-spin stretches pass with no feature at all, half of all waits end by spin 83, it takes 276 spins to reach a 90% chance, and 8.12% of players go 300 spins without one. A player who has just gone 300 spins dry faces an expected 120 more, the same as a player who sat down a moment ago.

> **The condition is a design choice, not a law of nature.** Equation (1) holds because the trigger draw is independent of the past by design. GLI-11 says so in the same breath as it allows the exception: outcomes must be available on every draw with the appropriate likelihood, "independent of previously produced outcomes, except where specified by the game design" (§3.2.5) **T1**. The exception is true persistence. On a game built with a stored counter, Equation (1) is false, and the help screen must say how the counter works.

3.3 A Model Machine, Tested

The program below builds two machines. The pot machine pays a base game on 30% of spins, lands a coin symbol on 4%, and triggers a feature worth an average 40 bets at 1 in 120; each coin fills the pot one level, from 1 (empty) to 5 (full), and the pot empties when the feature starts. The trigger line never reads the pot. The counter machine is true persistence: a hidden hit point drawn evenly from 1 to 240 spins, the feature certain by spin 240. The program counts, for each pot level shown before the spin and for each band of the counter, how many spins were played and how many triggered. It runs as printed under Python 3.12 in about seven seconds, and the output beneath it is that run.

PROGRESSION_SIM.PY

```
"""Perceived progression against true persistence: two model machines, one test."""
import random

P_FEATURE = 1 / 120             # chance of the feature on every spin
P_COIN = 0.04                   # chance a coin symbol lands and flies to the pot
BASE_PAYS = [0.4, 0.8, 1, 2, 5]  # base-game wins, in bets; one pays on 30% of spins
BONUS_PAYS = [10, 20, 30, 50, 90]  # feature wins, in bets; average 40


class PotMachine:
    """Perceived progression: the pot art follows the outcomes, never steers them."""

    def __init__(self, seed):
        self.rng = random.Random(seed)   # the only source of outcomes
        self.pot = 1                     # pot art: 1 (empty) to 5 (full)

    def spin(self):
        shown = self.pot                 # what the player sees before pressing SPIN
        r = self.rng
        win = r.choice(BASE_PAYS) if r.random() < 0.30 else 0.0
        coin = r.random() < P_COIN
        feature = r.random() < P_FEATURE          # no reference to self.pot
        if feature:
            win += r.choice(BONUS_PAYS)
            self.pot = 1                 # the art empties when the feature starts
        elif coin and self.pot < 5:
            self.pot += 1                # the art fills as coins land
        return shown, feature, win


class CounterMachine:
    """True persistence: a hidden hit point between 1 and 240 spins, must hit by 240."""

    def __init__(self, seed):
        self.rng = random.Random(seed)
        self.count = 0
        self.hit_at = self.rng.randint(1, 240)

    def spin(self):
        self.count += 1
        shown = self.count               # spins since the last feature, this one included
        feature = self.count == self.hit_at       # the stored state decides
        if feature:
            self.count = 0
            self.hit_at = self.rng.randint(1, 240)
        return shown, feature


def tally(machine, spins, band):
    seen, hits, paid = {}, {}, {}
    for _ in range(spins):
        out = machine.spin()
        k = band(out[0])
        seen[k] = seen.get(k, 0) + 1
        hits[k] = hits.get(k, 0) + out[1]
        if len(out) == 3:
            paid[k] = paid.get(k, 0.0) + out[2]
    return seen, hits, paid
```

```
if __name__ == "__main__":
    N = 10_000_000
    seen, hits, paid = tally(PotMachine(2026), N, lambda pot: pot)
    print("Pot shown  Spins      Features  P(feature)  1 in   Return")
    for k in sorted(seen):
        p = hits[k] / seen[k]
        print(f"{k:>9}  {seen[k]:>9,}  {hits[k]:>8,}  {p:.5f}   {1/p:5.1f}  {paid[k]/seen[k]:.2%}")
    seen, hits, _ = tally(CounterMachine(2026), N, lambda c: (c - 1) // 60)
    print("Counter    Spins      Features  P(feature)  1 in")
    for k in sorted(seen):
        p = hits[k] / seen[k]
        print(f"{60*k+1:>3}-{60*k+60:<5}  {seen[k]:>9,}  {hits[k]:>8,}  {p:.5f}   {1/p:5.1f}")
```

OUTPUT

```
Pot shown  Spins      Features  P(feature)  1 in   Return
        1  1,738,837    14,687  0.00845   118.4  89.09%
        2  1,428,270    11,914  0.00834   119.9  88.60%
        3  1,183,529     9,787  0.00827   120.9  88.24%
        4    979,863     8,199  0.00837   119.5  88.73%
        5  4,669,501    38,879  0.00833   120.1  88.54%
Counter    Spins      Features  P(feature)  1 in
  1-60     4,381,510    21,016  0.00480   208.5
 61-120    3,122,101    20,974  0.00672   148.9
121-180    1,869,319    20,727  0.01109    90.2
181-240      627,070    20,676  0.03297    30.3
```

Table 3.1 — The pot machine: the feature rate and return at each pot level, against what the level tracks

POT SHOWN BEFORE THE SPIN	SPINS	FEATURES	P(FEATURE)	RATE	RETURN	SPINS SINCE LAST FEATURE	SPINS TO NEXT FEATURE
Pot level 1	1,738,837	14,687	0.00845	1 in 118.4	89.09%	21.0	121.4
Pot level 2	1,428,270	11,914	0.00834	1 in 119.9	88.60%	41.5	119.3
Pot level 3	1,183,529	9,787	0.00827	1 in 120.9	88.24%	62.2	119.6
Pot level 4	979,863	8,199	0.00837	1 in 119.5	88.73%	82.5	120.2
Pot level 5	4,669,501	38,879	0.00833	1 in 120.1	88.54%	202.9	119.8

Exact values: $p = 1/120 = 0.008333$; return 55.20% base (0.30 × 1.84) plus 33.33% feature (40/120) = 88.53%. Independence of feature and pot level: $\chi^2 = 3.24$ on 4 degrees of freedom against a 5% critical value of 9.488; no level sits more than 1.64 standard errors from 1/120. The last two columns come from a separate run of the same machine (4,000,000 spins, seed 7): the mean spins since the last feature, counting the spin played, and the mean spins until the next.

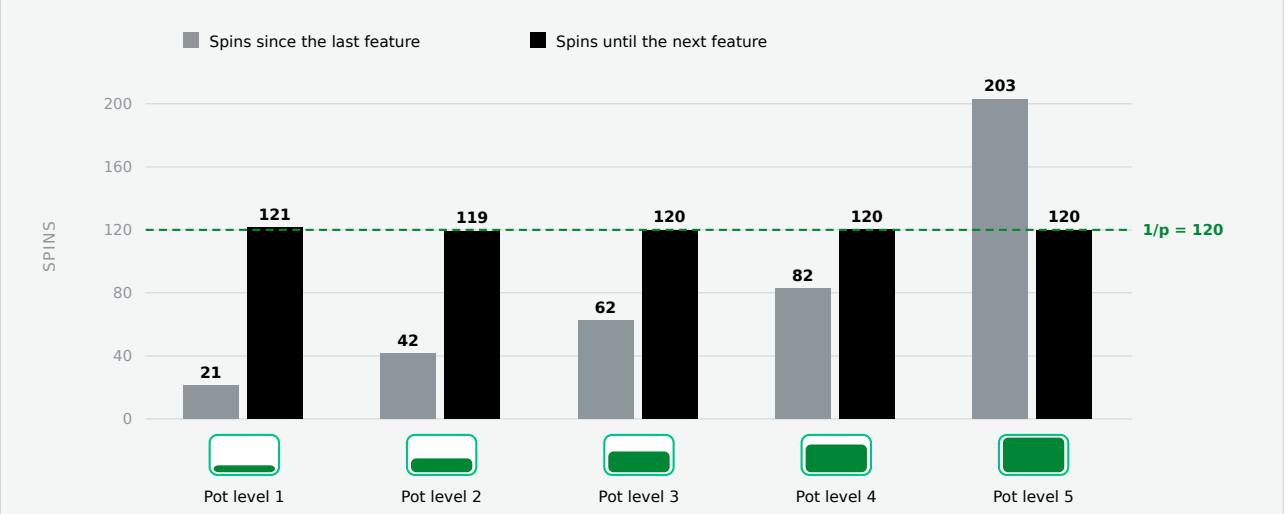


Figure 3 — What the pot tracks. The time since the last feature climbs with the pot, from 21 spins at level 1 to 203 at level 5, because the pot fills with play. The time to the next feature is 120 at every level. A full pot is a record of a long dry spell, and a long dry spell predicts nothing.

Table 3.2 — The counter machine: the same average wait, and a rate that climbs

COUNTER BAND	SPINS	FEATURES	P(FEATURE)	RATE	EXACT	EXACT RATE
Spins 1–60	4,381,510	21,016	0.00480	1 in 208.5	0.00475	1 in 210.5
Spins 61–120	3,122,101	20,974	0.00672	1 in 148.9	0.00664	1 in 150.6
Spins 121–180	1,869,319	20,727	0.01109	1 in 90.2	0.01105	1 in 90.5
Spins 181–240	627,070	20,676	0.03297	1 in 30.3	0.03279	1 in 30.5

Exact band rate: 60 features per 240 resets fall in each band, against $\Sigma(241 - c)$ spins played in it, since a spin at count c is reached with probability $(241 - c)/240$ and triggers with probability $1/(241 - c)$. The average cycle is 120.5 spins, nearly the pot machine's 120; only the counter machine has a state worth sitting down to.

3.4 Why the Return Cannot Depend on the Visual State

Let b be the wager, W the total pay on the next spin, and S_v the visual state shown before it. The return at visual state s is the expected pay given that state:

$$\mathrm{RTP}(s) = \frac{E[W_{n+1} \mid S_v = s]}{b} = \frac{E[W_{\text{base}} \mid s] + P(F \mid s) \cdot E[W_{\text{bonus}} \mid F, s]}{b} \tag{3}$$

The visual state is a function of the past: $S_v = g(U_1, \ldots, U_n, V)$, where the U_i are earlier draws and V any randomness the art uses for itself. The next spin's pay is a function of a fresh draw, $W_{n+1} = h(U_{n+1}, b)$, and the design makes U_{n+1} independent of everything that came before. A function of a fresh independent draw is independent of any function of the past, so every conditional expectation in (3) equals its unconditional value:

$$\mathrm{RTP}(s) = \frac{E[W_{\text{base}}] + p \cdot E[W_{\text{bonus}}]}{b} = \mathrm{RTP} \quad \text{for every } s, \quad \text{so} \quad \frac{\partial \mathrm{RTP}}{\partial S_v} = 0 \tag{4}$$

Because S_v takes whole-number levels, the derivative is read as a difference: $\mathrm{RTP}(s+1) - \mathrm{RTP}(s) = 0$ at every level. The proof needs both halves of the condition. Holding the trigger rate flat is not enough on its own: a pot that sets the size of the bonus, as Magic Treasures' numbered pot sets how many balls the bonus drops, leaves $P(F \mid s)$ alone and still raises $E[W_{\text{bonus}} \mid F, s]$. The zero holds when, and only when, neither the trigger nor the value reads the state. That is a property of the code, which a laboratory certifies, not of the artwork, which the player sees.

The model shows the zero in the data: across the five levels the return ran 88.24% to 89.09% against the exact 88.53%, a spread of the size sampling alone produces on a game whose feature pays up to 90 bets. On the counter machine the derivative is not zero: a spin at count 230 is worth the feature at 1 in 11, and a spin at count 10 at 1 in 231.

4 — WHY PLAYERS CHASE A POT THAT CANNOT PAY SOONER

If the pot changes nothing, its value to the maker is entirely in the player's head. The research below is graded by what it shows. Most of it was done outside slot machines, and the step from the laboratory to a filling pot is an inference, marked as one. This deep dive found no controlled study that isolates a filling-pot display and measures its effect on spin speed, bet size or time on device. The strongest evidence that the displays drive play is commercial: the makers build and sell them, and trade performance research has found game results "strongly associated with" perceived persistence among other mechanics (Volume II).

4.1 The Goal Gradient and Drive Reduction

Clark Hull's goal-gradient hypothesis (*Psychological Review*, 1932) held that an animal's effort rises as it nears a goal; his rats ran faster in the last stretch of a maze. It came a decade before his broader drive-reduction theory (*Principles of Behavior*, 1943), which treats behavior as driven by the reduction of a need, the reward closing the loop. The gradient has held up in people. Kivetz, Urminsky and Zheng (*Journal of Marketing Research*, 2006) found café customers bought coffee more often as their reward card neared a free drink, and that a 12-stamp card handed out with two stamps already filled was completed faster than a 10-stamp card with none: the same ten purchases, but the illusion of a head start sped them up.

A pot is that pre-stamped card with no stamps that count. It shows distance to a goal on a scale the player can read, and the closer it looks, the stronger the gradient's pull should be. That the pull raises spin speed or bet size at a slot is a reasonable inference from this research, not a measured result.

4.2 The Zeigarnik and Ovsiankina Effects

Bluma Zeigarnik reported in 1927 (*Psychologische Forschung*) that people recalled interrupted tasks better than finished ones; Maria Ovsiankina reported in 1928 that people tend to go back and finish a task that was interrupted. The memory claim is the one usually cited, and it is the weaker of the two. Ghibellini and Meier's 2025 meta-analysis (*Humanities and Social Sciences Communications* 12, article 962) found that the Zeigarnik memory advantage lacks general validity, while the Ovsiankina urge to resume is a general tendency T2.

So the accurate statement is not that a half-full pot is remembered more vividly. It is that an unfinished display invites the player to finish it. A pot that is three-quarters full presents an interrupted task, and the resumption tendency, the effect that replicates, favors sitting down again or staying put. The application to slots is inference.

4.3 Reinforcement Schedules

Ferster and Skinner's *Schedules of Reinforcement* (1957) set out how the rule linking responses to rewards shapes behavior. On a fixed-ratio schedule the reward comes after a set number of responses, and responding pauses after each reward. On a variable-ratio schedule the number varies around an average, and responding is high, steady and slow to extinguish. Skinner pointed to gambling devices as the commercial use of the variable ratio (*Science and Human Behavior*, 1953). A slot's feature at a fixed chance per spin is a random-ratio schedule, the constant-probability form of the variable ratio: the chance of a reward on the next response never changes, however long the drought.

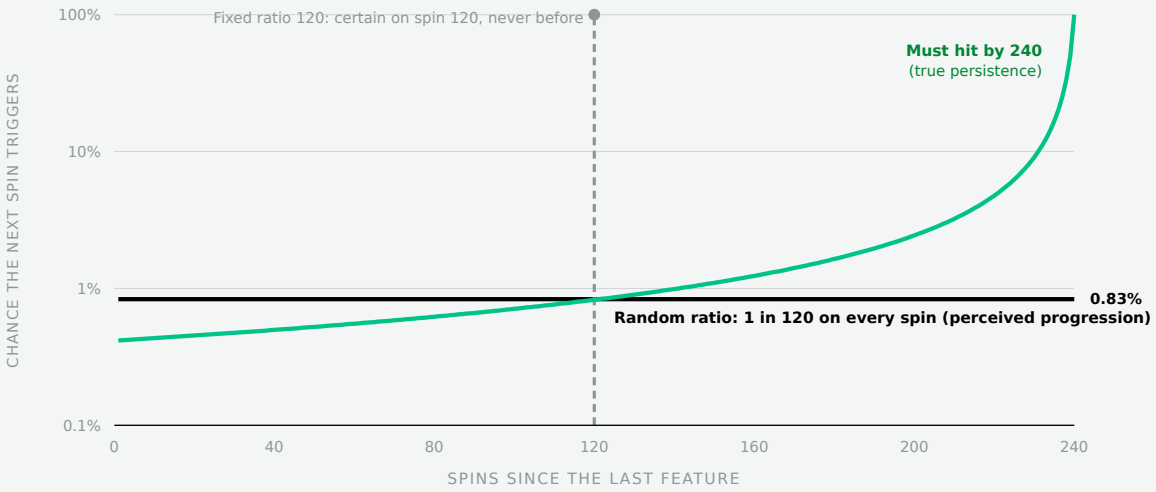


Figure 4 — Three schedules with nearly the same average. The chance that the next spin triggers, against spins since the last trigger, on a log scale. The perceived-progression game is the flat line: 1 in 120 on every spin. A fixed ratio of 120 pays only on spin 120. A must-hit-by counter with a hit point drawn evenly from 1 to 240 climbs from 1 in 240 to certainty. A pot that fills dresses the flat line in the look of the rising one.

That is the core of the illusion, drawn in Figure 4. The pot borrows the look of a schedule that rises toward a payoff, the fixed ratio or the must-hit-by, and lays it over a schedule that is flat. The player reads the gauge as the rising curve while the machine runs the flat one, and the flat one is the schedule that is hardest to walk away from.

4.4 The Gambler's Fallacy

Tversky and Kahneman's "Belief in the Law of Small Numbers" (*Psychological Bulletin*, 1971) described the expectation that a random sequence will correct itself over short runs, so that a long absence makes an outcome "due." A filling pot is that belief drawn on the glass: it grows exactly when the feature has been absent and empties exactly when it arrives. Nevada has now ruled on the words, though not the art. Since February 26, 2026, "An EGD may not use language that suggests the probability of a particular outcome is more likely to happen than its actual probability," with "Due," "Overdue" and "Ready to Hit" named as examples (Technical Standard 1.600(9)) **T1**. A pot that says "due" without a word is outside the letter of that rule and squarely inside the belief it addresses.

4.5 Loss Aversion, Sunk Cost and the Fear of Leaving

Players often refuse to leave a machine showing a full pot, and some hunt for one. The trade calls it abandonment; the research has older names for its parts. Loss aversion, the finding that a loss weighs more than a gain of the same size (Kahneman and Tversky, *Econometrica*, 1979), makes the imagined loss of a full pot to the next player loom large. The sunk-cost effect (Arkes and Blumer, 1985) makes the money already fed into the machine feel invested in the pot. Anticipated regret, picturing the next player hitting, finishes the job.

The arithmetic answers all three. On perceived progression, walking away from a full pot leaves nothing on the machine, because the next player's spin carries the same 1-in-120 chance as the departing player's would have, and a player who searches the floor for full pots has bought nothing but the walk. On true persistence the fear is rational, and that is the line advantage players work: a must-hit-by bank near its ceiling (Volume III) or a Phoenix counter near 1,888 (Volume XIII) does carry value to the next player.

4.6 Losses Disguised as Wins and Near Misses

Dixon, Harrigan, Sandhu, Collins and Fugelsang (*Addiction*, 2010) recorded skin conductance and heart rate in 40 novice players on a multi-line slot. A loss disguised as a win, a payout smaller than the bet celebrated like a win, drew skin-conductance responses about the size of those to real wins and larger than those to plain losses **T2**. Later work by the same group found that the win sounds carry much of the effect and that players count such outcomes as wins. On a $2.00 bet, a $0.40 win is a $1.60 loss; if a coin flies to the pot on that spin, the machine celebrates twice on a losing spin. The study measured arousal, not dopamine, and claims that pots or LDWs "release dopamine" go past what it shows.

The near miss works on the same circuitry. Clark and colleagues (*Neuron*, 2009) found that near misses raised the desire to keep playing and recruited the brain's win-related reward regions, though they paid nothing. A pot one coin from full is a near miss that lasts as long as the player stays.

Table 4.1 — The mechanisms, the evidence, and the step to the pot

MECHANISM	SOURCE	WHAT THE RESEARCH SHOWS	APPLIED TO A FILLING POT
Goal gradient	Hull 1932; Kivetz et al. 2006	Effort rises near a goal; a head start, even an illusory one, speeds completion	A full pot reads as near; inferred, not tested on slots
Zeigarnik / Ovsiankina	Zeigarnik 1927; Ovsiankina 1928; Ghibellini and Meier 2025	Memory for unfinished tasks: not general. Urge to resume: general	An unfinished pot invites resumption; inferred

MECHANISM	SOURCE	WHAT THE RESEARCH SHOWS	APPLIED TO A FILLING POT
Random-ratio schedule	Ferster and Skinner 1957; Skinner 1953	Constant-chance reward sustains high, persistent responding	The pot dresses a flat schedule as a rising one
Gambler's fallacy	Tversky and Kahneman 1971	People expect short runs to self-correct	The pot grows exactly when the feature has been absent
Loss aversion; sunk cost	Kahneman and Tversky 1979; Arkes and Blumer 1985	Losses loom larger; spent money pulls more spending	Fear of leaving a full pot; rational only on true persistence
Losses disguised as wins	Dixon et al. 2010	LDWs arouse like wins (skin conductance)	Coin-to-pot animations on losing spins
Near misses	Clark et al. 2009	Near misses raise the urge to play and recruit reward regions	A nearly full pot is a standing near miss

5 — WHAT THE STANDARDS ACTUALLY REQUIRE

Two documents govern most American slot floors: the state's own regulations and technical standards, and Gaming Laboratories International's GLI-11, which most jurisdictions adopt by reference and which the laboratory tests every game against. Neither prescribes a sentence for a pot. Both reach it through general duties of accuracy, randomness and disclosure, and GLI-11 adds a specific duty for true persistence. The texts below are quoted from the primary documents: Nevada Gaming Commission Regulation 14 in its August 2026 text, the Nevada Gaming Control Board's Technical Standard 1 adopted February 26, 2026, and GLI-11 Version 3.0 of September 21, 2016, the edition GLI lists as current T1.

Table 5.1 — The provisions that reach a progression display

PROVISION	WHAT IT SAYS	WHAT IT MEANS FOR A POT
Nev. Reg. 14.040(1)(b)	Devices must "Determine game outcome solely by the application of" chance, skill, or both	The pot cannot be an input unless the game is a skill or hybrid game, which must say so (14.040(5))
Nev. Reg. 14.040(1)(c)	"Display in an accurate and non-misleading manner: (1) The rules of play," the wager, the pays and the outcome	"Rules of play" includes help screens (14.010(32)); a help screen that implied a full pot pays sooner would breach it
Nev. Reg. 14.040(3)	"All possible game outcomes must be available upon the initiation of each play of a game"	The feature must be reachable from an empty pot; the series quotes this line against the "overdue" keno number (Volume XVI)
Nev. Reg. 14.040(6)	Devices "must not alter any function of the device based on the actual hold percentage"	No hidden tightening or loosening as a machine runs hot or cold
Nev. TS 1.100(1)	"If a reel symbol is displayed to the player, it must be available for random selection"	Displayed symbols are real; this does not reach art above the reels
Nev. TS 1.600(7)	If a game's rules, "including the probability and award of a game outcome," change during a session, the rules must say which elements change and why	A pot that truly changes the odds must be disclosed; the standard's example: "The chance of winning the XYZ award/feature/jackpot increases with the amount wagered"
Nev. TS 1.600(9)	"An EGD may not use language that suggests the probability of a particular outcome is more likely to happen than its actual probability"	Bars "Due," "Overdue" and "Ready to Hit"; reaches words on a pot, not the pot's art
GLI-11 §3.2.5	Outcomes available "independent of previously produced outcomes, except where specified by the game design"	The independence behind Equation (1), and the opening for true persistence
GLI-11 §4.4.1(a)	Rules of play "shall be complete and unambiguous and shall not be misleading or unfair to the player"	Applies to "any written, graphical, and auditory information," so it reaches the art
GLI-11 §4.5.1(a)	An illusion of skill "for entertainment value only" must be fully disclosed "within the game help screens"	The one place GLI requires an "entertainment" disclosure: for skill illusions, not pots
GLI-11 §4.7.2(c)	The game "shall not display a 'near miss' where it makes a variable secondary decision which affects the result shown"	The outcome shown must be the outcome drawn
GLI-11 §4.21.2	Help screens must give "a clear description of each persistence game-related feature" and the thresholds; "players shall be notified each time a persistence game threshold has been achieved"	True persistence must be explained; perceived progression has no such duty because it has no thresholds

5.1 What Is Not Required

No provision in Regulation 14, Technical Standard 1 or GLI-11 requires a game with a filling pot to print a disclaimer, and none prescribes wording such as "for visual representation only." The disclaimers that appear are the makers' own, written to keep the help screen accurate under the general duties above: Light & Wonder's "The appearance of pots and fire over time is for presentation only" on Big Hot Flaming Pots, and Dancing Drums' "The accumulation of COINS over time in COIN POT has no effect on triggering the Jackpot Bonus," followed by "The Jackpot Bonus has a chance of being triggered on every spin!" (Volumes II and IX) T1. Many games print nothing. On Spooky Link no title's rules speak to the gem pots, and the classification rests on Aristocrat's patent (Volume VIII).

> **The rule in one paragraph.** A perceived-progression display is lawful in Nevada and under GLI-11 so long as the outcome is drawn independently of it, nothing on the screen or in the help states or implies that it raises the chance, and its words avoid "due" and its kin. A display that does change the odds or the value is a persistence feature: the help must describe it and its thresholds, the player must be told when a threshold is reached, and in Nevada the rules must say how the chance changes. The silence of a help screen proves neither case; the volume's rules, the patent or the maker's own label has to settle it.

6 — READING A PROGRESSION DISPLAY ON THE FLOOR

1. **Read the help screen for the display's own sentence.** "For presentation only," "no effect on triggering" or "a chance of being triggered on every spin" settles it as perceived progression. "Must be won before," "must hit by," "increases the chance" or a stated threshold settles it as true state.
2. **Ask what the display counts and whether any rule ties the count to the odds or the value.** A pot that fills with play and empties at the feature is an elapsed-play record: it shows how long, never how soon.
3. **Do not use the cash-out test.** Whether the art survives a cash-out decides nothing. Decorations often stay on the machine, and a real must-hit-by bank stays too; that is why advantage players can find it.
4. **Look for a printed ceiling.** Only bounded, visible state can be priced: the Phoenix counter's 1,888, the wild banks' 75, 100 and 125. An unbounded meter carries value, not odds.
5. **Price the difference.** With no rule tying the display to the outcome, ΔEV = 0 at every level and the display is worth nothing to the player. With a bounded counter, the next spin's chance is the counter's hazard, 1/(ceiling + 1 − count) on an even hit point, and the expected value follows from the prize.
6. **Treat the look as zero information.** The model machine's full pot fired at 1 in 120.1 and its empty pot at 1 in 118.4. The fill tells you how long the last player waited.

Table 6.1 — What the next spin is worth: the counter machine against the pot machine

SPIN SINCE THE LAST FEATURE	COUNTER: CHANCE OF THE FEATURE	COUNTER: FEATURE VALUE, BETS	POT MACHINE: FEATURE VALUE, BETS	COUNTER: RETURN ON THAT SPIN
Spin 1	1 in 239.8	0.167	0.333	71.9%
Spin 60	1 in 181.2	0.221	0.333	77.3%
Spin 120	1 in 121.1	0.331	0.333	88.3%
Spin 152	1 in 89.0	0.449	0.333	100.1%
Spin 180	1 in 61.0	0.656	0.333	120.8%
Spin 200	1 in 41.0	0.976	0.333	152.8%
Spin 220	1 in 21.0	1.905	0.333	245.7%
Spin 230	1 in 11.0	3.636	0.333	418.8%
Spin 240	Certain	40.000	0.333	4,055.2%

Both machines with the pot machine's base game (55.20% of the bet) and its feature, averaging 40 bets. Feature value is the chance times 40. On the pot machine it is 40/120 = 0.333 bets at every pot level. On the counter machine the hit point is even on 1 to 240, so spin c triggers with chance 1/(241 − c), and from spin 152 on, the next spin returns more than it costs; over a whole cycle the counter machine returns 88.40%, nearly the pot machine's 88.53%. A player who knows the count can pick the spins worth playing. On the pot machine there are none to pick.

Every volume of the series applies this method in its Appendix C, and the series' Perceived Progression page carries the result for each game: Dancing Drums' coin pot as the archetype of the elapsed-play record, Dragon Link and Lightning Link as the null case with nothing that fills, and Phoenix Link, Lightning 10 Year Storm, Regal Riches and Magic Treasures as the true state worth knowing.

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About the Slot Intelligence Series

Casino game mathematics is treated as unknowable by almost everyone who writes about it. Most of it is. A surprising amount is not — it sits in manufacturer specification sheets, published game rules, regulatory filings, court records and licensed-operator disclosures that nobody bothers to read side by side. The series reads them side by side, one game family at a time. Every source is graded by tier, every derived figure shows its arithmetic, every bad number in circulation is named, and where a figure is not public the volume says so. This deep dive sets out the standard every volume uses to separate a display that looks like progress from state that is.

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