Dual-Path Driver Analysis (DPDA)

Identify which closure cues improve cap experience and how those improvements translate into total product experience

Objective: Move beyond simple correlation by quantifying

→ 01

Direct Drivers

Closure phenomena that directly improve cap experience and/or overall product experience

02

Indirect Drivers

Phenomena influencing overall experience through improving closure experience

↔ 03

Dual-Impact Drivers

Cues strengthening both closure experience and total product perceptions

Analytical Framework

STEP 1 | Joint Driver Modeling

A Seemingly jointly driver models:

Closure Experience + **Overall Product Experience**

while accounting for shared variance across the two outcomes.

This helps identify:

- Cap-experience-specific drivers
- Overall-experience drivers
- Shared dual-impact drivers

STEP 2 | Mediation Impact Decomposition

For significant drivers, mediation modeling separates:

Total Impact = Direct Effect + Indirect

Indirect effect pathway:

Phenomenon → Closure Experience → Overall Experience

This quantifies whether a driver works mainly through functional usability or also contributes directly to emotional product perception.

Why This Approach

Compared with standard driver analysis, this framework captures:

✓ Shared drivers across two linked outcomes

✓ Direct vs indirect impact pathways

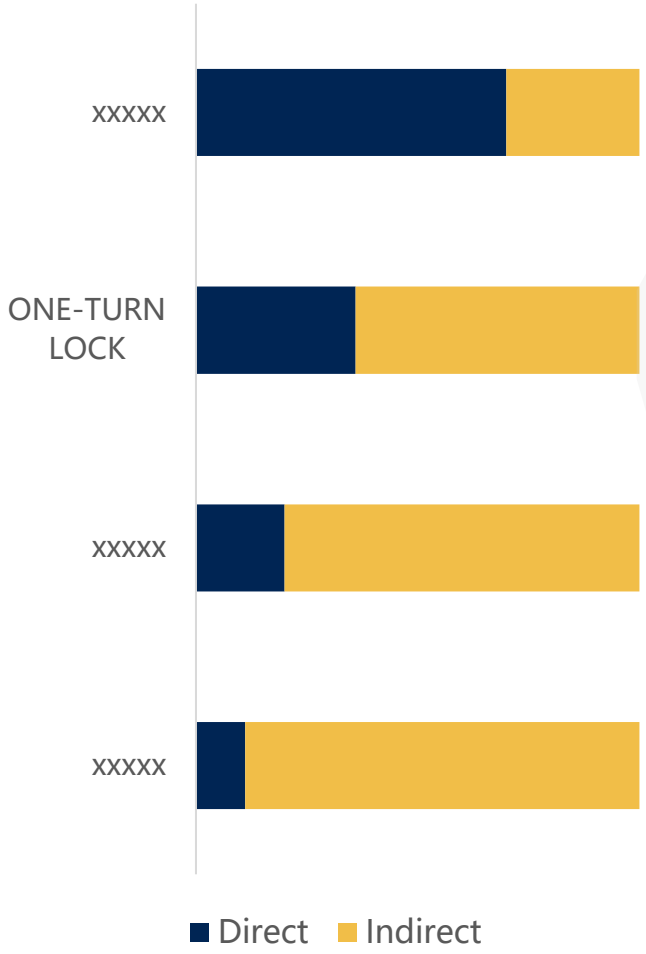
✓ Prioritization of features with highest experiential leverage

★ DPDA combines joint outcome driver modeling and mediation decomposition to distinguish which closure cues improve experience directly, indirectly, or through both pathways.

Output: Driver Prioritization

Closure Cue	Impact on Cap Exp	Direct Impact on Overall	Indirect Impact via Cap Exp	Driver Type
Clear click sound	**High**	Low	High	Translational
One-turn lock	**High**	Medium	High	Dual
Torque resistance	Medium	**High**	Medium	Emotional
No slippage	**High**	Low	Medium	Foundational

Output: Effect Decomposition



ONE-TURN LOCK

+0.42

Total Effect on Overall Experience

Direct Effect

+0.15 36%

Indirect via Closure Exp

+0.27 64%

Interpretation

Most impact comes from **improving functional closure experience**, rather than purely symbolic perception.

Key Takeaway

The **64% indirect effect** indicates that one-turn lock's primary value is delivering a superior closure sensation that cascades into overall product satisfaction.

Output: 象限图


Performance
Impact
Secondary Optimization
Low impact
+ High performance
Nice-to-have improvements with limited leverage.
Maintain Advantage
High impact
+ High performance
Continue current strategy. These cues are working well.
Lower Priority
Low impact
+ Low performance
Monitor but don't prioritize. Limited impact on experience.
Prioritize Improvement
High impact
+ Low performance
High-impact opportunities. Focus resources here for maximum ROI.

Perception Association Network Analysis (PANA)

Mapping how closure cues shape product perceptions through an interconnected network

Objective: Go beyond isolated driver relationships to understand how closure-related cues connect with broader product perceptions as a system.

01

Perception-building cues

Which closure phenomena are most strongly associated with positive product perceptions

02

Association clusters

Groups of closure cues and perceptions that naturally reinforce one another

03

Central “Hub” attributes

Cues serving as key anchors that influence multiple perceptions simultaneously

Analytical Framework

STEP 1 | Construct Association Network

A network is built linking:

- Closure phenomena
- Product perceptions

Connections represent **unique associations** after controlling for all other variables

(Conditional Mutual Information Network)

STEP 2 | Identify Network Structure

The model reveals:

- Strongest cue-perception linkages
- Natural clusters (communities)
- Central nodes (high influence hubs)

This isolates meaningful relationships beyond simple pairwise correlations.

STEP 3 | Design Implications

Different cues contribute differently:

- Functional reassurance
- Premium signaling
- Ease-of-use signaling

The network shows which sensory signals are most effective for building each perception.

Why Use Network Analysis

Compared with standard correlation matrices:

✓ Removes spurious overlap among attributes, isolating true unique relationships

✓ Reveals perception ecosystems, not isolated links — understanding the full network effect

✓ Identifies multi-perception "hub" cues with outsized leverage across the network

Output: Network Map Interpretation

Conditional Mutual Information Network (CMI Network)

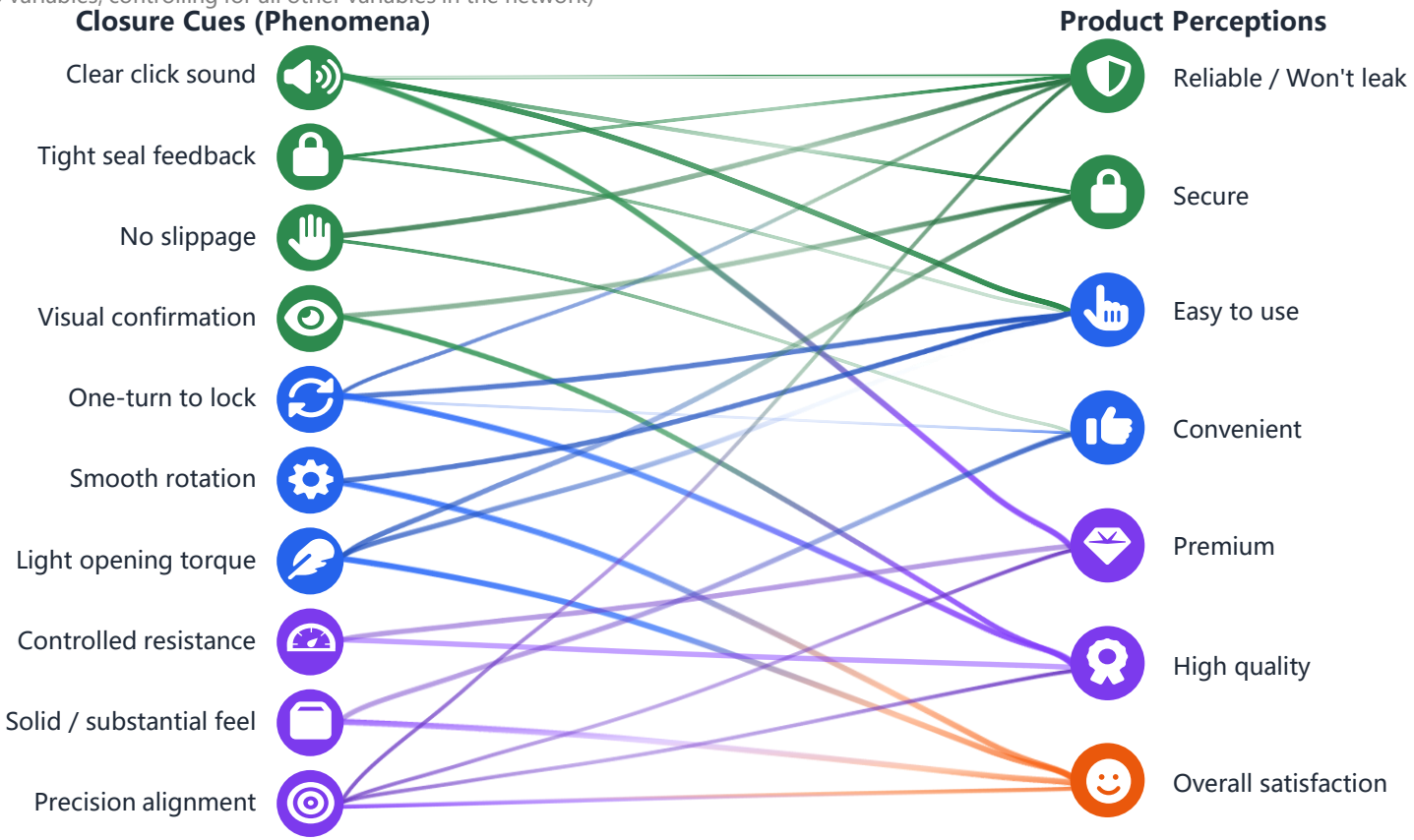
Edges represent conditional mutual information $I(X;Y|Z)$
(information shared between two variables, controlling for all other variables in the network)

Functional Confidence
Signals that confirm proper closure and protection

Ease of Use
Signals that make closing effortless and convenient

Sensory Quality
Signals that convey quality through touch

Overall Outcome
Holistic evaluation of the product experience



Edge Strength (Conditional Mutual Information)

- Very Weak (0.00–0.04)
- Weak (0.04–0.08)
- Moderate (0.08–0.14)
- Strong (0.14–0.20)
- Very Strong (>0.20)

Higher values = more unique information shared between variables.

Cluster (Communities)

- Functional Confidence
- Premium Perception
- Ease & Convenience
- Overall Outcome

Key Hub Cues (Centrality)

Cue (Phenomenon)	CMI Degree Centrality
Clear click sound	1.36
One-turn to lock	1.18
Controlled resistance	1.05
Tight seal feedback	0.94
Smooth rotation	0.82

Higher centrality = greater unique information influence across the perception network

Network Insights (CMI)

✓ Conditional information detects both linear and non-linear unique relationships.

✓ Clear click sound is the most information-rich cue, shaping multiple perceptions across clusters.

✓ One-turn to lock strongly drives ease-related perceptions through meaningful unique information.

✓ Controlled resistance is the key cue building premium perception and overall quality.

✓ CMI network removes spurious links explained by other variables, highlighting the true influence structure.

Top Cue–Perception Associations (by Conditional Mutual Information)

Closure Cue (Phenomenon)	Perception	CMI (I|Z)	Strength
Clear click sound	Reliable / Won't leak	0.28	Very Strong
Clear click sound	High quality	0.25	Very Strong
Tight seal feedback	Reliable / Won't leak	0.24	Very Strong
One-turn to lock	Easy to use	0.23	Very Strong
No slippage	Secure	0.21	Very Strong

Closure Cue → Perception	Perception	CMI (I|Z)	Strength
Controlled resistance → Premium	Premium	0.24	Very Strong
Solid / substantial feel → High quality	High quality	0.22	Very Strong
Precision alignment → Premium	Premium	0.19	Strong
Smooth rotation → Easy to use	Easy to use	0.18	Strong
Visual confirmation → Secure	Secure	0.14	Moderate

How to Read This CMI Network

Edges show unique info between variables. → **Stronger edges** = more explanatory info. → **Clusters** = perception ecosystems. → **Focus** on high-centrality cues.

Notes: Network estimated using Conditional Mutual Information (Kraskov estimator, k=5) with strength threshold |I| >= 0.04 for edge retention.