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Correlation Is Not Enough: Configurational Outcome Modelling (COM) Reveals Hidden Causal Structures in Complex Systems — A Next-Generation Alternative to Correlation-Only Inference

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We use this protocol and it's working

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Keywords: configurational influence assessment method, configurational outcome modelling, dynamic configurational effect, generation alternative to correlation, formative indicator logic, hidden causal structures in complex system, data structure requirement, specified dependent variable, cia, set membership score, cognitive flexibility, trait variable, organizational behaviour, membership score, correlation, based approach, scale, variable, dependent variable

Abstract

This protocol describes the Configurational Influence Assessment Method (CIAS), a non-linear behavioural measurement procedure designed to quantify how Context, Situational Pressure, and Trait variables interact within real or imagined situations to influence a specified dependent variable. Unlike traditional correlational or Likert-based approaches that measure simple co-occurrence, CIAS captures the dynamic configurational effect that emerges when independent variables are simultaneously present. Participants rate triad-grouped items on a continuous 0–100 scale, enabling fractional precision and preserving contribution asymmetry. Raw values are calibrated into fuzzy set membership scores using pre-defined anchor points (0.0, 0.5, 1.0) prior to set-theoretic analysis. Boolean minimization is used to determine necessity, sufficiency, and solution coverage. This method accommodates formative indicator logic, where lower internal consistency is expected due to conceptual non-redundancy. The protocol includes operator instructions, quality-control safeguards, stopping rules, and data structure requirements to ensure reproducibility. CIAS is suitable for research in decision-making, leadership, organizational behaviour, clinical profiling, and cognitive flexibility, and is optimized for publication, replication, and transparent dissemination.

Image Attribution

Image for visualization of configuration vs correlation purpose only.

Guidelines

- Familiarity with fsQCA concepts (necessity/sufficiency, calibration)
- Experience with membership calibration and anchoring justification
- Training in triad administration and quality-control detection (stereotyped patterns, rounding bias)



Materials

- Continuous 0–100 rating interface (digital preferred)
- The full item set representing each configurational element (Context, Situational Pressure, Trait)
- Data entry template (CSV or XLSX)
- Software capable of performing fsQCA (e.g., fsQCA 3.1, R package "QCA", or Tosmana)
- Instructions sheet for participants
- IRB-approved consent form
- Scoring sheet for item-triad groupings

Before start

All materials must be identical across researchers to ensure reproducibility. Researchers must specify software version and calibration command settings in the dissemination statement.

PHASE I: Configurational Validation (CTRM Protocol)

- 1 Define the N distinct elements (e.g., Context, Situational Pressure, Trait) that form the configuration and the Dependent Variable (DV).
A clearly defined theoretical model (e.g., a Triad, Quadrad).
- 2 Develop a full item set to represent each element. Crucially, split the total item pool into at least two independent, theoretically parallel sets.
Parallel item sets ready for administration.
- 3 Recruit Subject Matter Experts (SMEs) N Approximate 30 and conduct two tasks:
Item Understandability: High Interclass Correlation (ICC) (e.g., ICC = 0.785).
Distinctiveness: High Mean Likert Rating (≥ 4.0 out of 5) and a statistically significant RM-ANOVA.
- 4 Administer the full instrument to a large sample (N = 100+) and calculate Cronbach's alpha for the items within each single element (IV).
Expected Failure (Theoretical Success): A low α (e.g., α approx. 0.129) is required, confirming the elements are distinct formative indicators.
- 5 Calculate the two configurational coefficients using the composite scores from the main sample.
Intra-Configuration Coherence (r1): High value (e.g., 0.80), proving systematic alignment within the configuration. Global Conceptual Stability (r2): High value (e.g., 0.80), correlating Set A vs. Set B total scores, proving stability across item sets.

PHASE II: Data Collection & Preparation (CIAS Protocol)

- 6 Mandatory Check: Confirm that Phase I has been successfully completed, with (r1) and (r2) achieving high values.
CTRM Validation Report must show (r1) and (r2) are high.
- 7 Group the related items of each configurational element into triads (e.g., Context Item, Situational Pressure Item, Trait Item) under shared conceptual domains (e.g., Integrative Coherence).
Minimum 6 triads per participant.
- 8 Present real or imagined situations and instruct participants to score each item using the free continuous scale of 0 (not applicable at all) to 100 (perfectly applicable). The Dependent Variable (DV) is also scored on this 0-100 scale.
Raw continuous decimal values recorded for all IVs and the DV.
- 9 Discontinue administration if fatigue or identical/stereotyped patterns occur (e.g., $\geq 20\%$ triads with identical values). Exclude data if quality control metrics are violated.
High-quality data set of raw 0-100 scores from N ≥ 25 participants.



PHASE III: Non-Linear Analysis (fsQCA Protocol)

- 10 Transform all raw 0-100 scores (for both IVs and DV) into 0.0-1.0 fuzzy membership scores using an S-shaped function.
The three anchor points must be set: Full Non-Membership: 5 to 0.0; Crossover Point: 50 to 0.5. Full Membership: 95 to 1.0
- 11 Test if any single IV or combination of IVs is a necessary condition for the DV (Outcome).
Necessity Consistency Score 0.90 indicates the outcome almost never occurs without that condition.
- 12 Process data into a Truth Table and use Boolean minimization (Quine-McCluskey) to generate the most parsimonious solution (combinations of IVs sufficient for the outcome).
Solution Term (e.g., High Context AND High Trait) and Solution Consistency
- 13 The distinct, non-linear contribution is quantified by the key fsQCA metrics.
Solution Consistency 0.80 (reliably sufficient) and Solution Coverage 0.50 (empirical relevance).

Protocol references

Ramesh Kumar G S (2025): A Solution to the Reliability Paradox: The Configurational Triad Rating Method (CTRM) Procedure for Configurational Personality Assessment, Protocols.io. DOI:10.17504/protocols.io.14egnr14ml5d/v1

Acknowledgements

Minimum Data Requirements:

- Minimum 6 triads per participant
- Minimum 10–15 participants for exploratory analyses
- Minimum 25+ participants for stable fsQCA models

Estimated Time:

- Practice triad: 1–2 minutes
- Each triad: 2–3 minutes
- Total per participant (6 triads): 15–20 minutes

Step-by-Step Procedure (Operator Instructions):

1. Select Dependent Variable Context
 - Define a single behavioural outcome case (e.g., “investment decision”).
2. Select Three Configurational Elements
 - Confirm Context, Situational Pressure, Trait.
3. Verify Element Distinctiveness
 - Conduct CTRM $r1/r2$ validation to ensure conceptual separation.
4. Assign Items to Triads
 - Group three items (C, SP, T) under each shared conceptual domain.
5. Administer Practice Triad
 - Ensure participant comprehension of continuous scaling.
6. Present Real or Imagined Situation(s)
 - Have participant mentally relive the scenario for 30–90 seconds.
7. Score Each Item (0–100)
 - Capture influence strength for each configurational element.
8. Record Outputs
 - Enter continuous decimal values into structured data template.
9. Repeat Across Triads
 - (Recommended minimum = 6 triads)
10. Compile Composite Scores
 - Sum/average within each configurational element.
11. Proceed to Calibration
 - Fuzzify raw values to obtain membership scores (0.0–1.0).
12. Conduct fsQCA Analysis
 - Perform:
 - Necessity test
 - Sufficiency test
 - Solution term derivation
13. Interpret Configurational Effect
 - Evaluate coverage and consistency metrics.

Instruction:

- The subject is given freedom. To a selected situation, the subject is asked if each item was applicable and to what extent.
- The subject must give rating from 0 (not applicable at all) to 100 (perfectly applicable) on a 'continuous scale'. Thus, for example, to Context item under 'Integrative Coherence' he can give 19.1 as applicable, 0 (not at all applicable) for Situation Pressure Item and 67.8 for Trait Item.
- Participants should not round values unless genuinely felt; decimals capture nuance.

Respect To Human Limitation:

- First a practice situation with one set of three comparable items (i.e., one triad) given. This helps the subject overcome the effect of human limitation in understanding and adapting to new tasks, though the answers going to be from his own past personal experience well known to himself.

Meaning of the Scores:

- The scores indicate the configuration
 - for example, in a particular "Investment Decision" (Dependent Variable) the executive had a configuration of 19.1 influence of Context, 0 influence of Situation Pressure and 67.8 influence of Trait in the particular investment decision, he made.

Stopping Rules:

- Discontinue administration if:
 - participant shows rating fatigue, or more than 20% of triads produce identical values
 - ratings collapse into stereotyped patterns
 - High-quality data set of raw 0-100 scores from $N \geq 25$ participants. This minimum threshold ($N \geq 25$ cases) is mandatory for the fsQCA truth table analysis.
 - Such data should be flagged and excluded.

Data Structure Requirements (Raw):

Column Name	Description	Allowed Values
Participant_ID	Unique identifier	Alphanumeric
Case_Instance	Situation number (1-10 recommended)	Integer
IV_Context	0-100 continuous strength score	Decimal (0.0-100.0)
IV_SituationPressure	0-100 continuous strength score	Decimal (0.0-100.0)
IV_Trait	0-100 continuous strength score	Decimal (0.0-100.0)
Dependent_Variable	0-100 rating where applicable	Decimal
Triad_ID	Identifies which conceptual sub-domain	String

Common Operator Errors:

- Treating 0-100 as ordinal rather than continuous
- Rescaling values externally before calibration
- Mixing Likert items with continuous items

- Collapsing decimals to integers

These invalidate configurational computation.

Quality Control Requirements:

- Data are excluded if:
 - 80% triads have identical patterning.
 - Any configurational element is always rated 3e95 across triads.
 - Participants default to round numbers (10, 20, 30) across $\geq 80\%$ of triads.

Such patterns indicate non-engagement.

Data Management and Statistical Analysis: Data Management

- Data will be recorded in a structured database, linking each set of configuration scores (IV1, IV2, IV3) and the DV score (if applicable, also on a 0-100 scale) to the specific case instance. The raw data consists of continuous scale scores for each IV for every case instance.

Fuzzy membership scores (.00–1.00) must be stored as decimals with at least 2–3 decimal precision.

Calibration must be performed *after* composite scoring and *before* necessity/sufficiency analysis.

Operator Skill Requirements

- Familiarity with fsQCA concepts (necessity/sufficiency, calibration)
- Experience with membership calibration and anchoring justification
- Training in triad administration and quality-control detection (stereotyped patterns, rounding bias)

Non-Linear Statistics: Fuzzy-Set Qualitative Comparative Analysis (fsQCA)

- To quantify the synergistic "configurational effect," which is non-linear and non-additive, the methodology will employ Fuzzy-Set Qualitative Comparative Analysis (fsQCA). This method is specifically designed for set-theoretic research, focusing on how combinations of conditions lead to an outcome, rather than the net effect of individual variables.

Required Steps for Non-Linear Processing:

1. Calibration (Fuzzification) of Raw Data:

- The continuous scores (0–100) are used as initial membership scores in calibration.
- The raw continuous scores must be transformed into full fuzzy membership scores, typically ranging from 0.0 (full non-membership) to 1.0 (full membership).
- Anchors: The researcher defines three qualitative anchors (e.g., a score representing full membership, a score for the crossover point, and a score for full non-membership) to convert the raw continuous score into the precise fuzzy membership score.
- Recommended Numerical Anchor Points: To ensure replicability of the fuzzy-set transformation, the researcher must specify the precise scores for these anchors. It is recommended to use an asymmetric S-shaped function based on the following three points: a raw score of 5 is set as full non-membership (0.0); a score of 50 is

set as the crossover point (0.5), where the case is neither more in nor more out of the set; and a score of 95 is set as full membership (1.0). All other scores are algorithmically mapped to a corresponding fuzzy membership score between 0.0 and 1.0.

Calibration Method

- Raw continuous scores must be transformed into fuzzy sets using an S-shaped function with the following anchors:

- Full non-membership: 5 → 0.0
- Crossover point: 50 → 0.5
- Full membership: 95 → 1.0

Intermediate values are interpolated using the logistic transformation as implemented in fsQCA software.

These anchor points must not be altered without justification.

(fsQCA → calibrate function; R/QCA package → calibrate)

Necessity Analysis:

- The first non-linear test is to determine if any single IV or combination of IVs (the configuration) is a *necessary* condition for the DV (Outcome).
- The Consistency Score for necessity is calculated as a *ratio*: the total evidence where both the condition and the outcome are present (the overlap) is divided by the total evidence of the condition alone (the total presence).
- Interpretation: A high consistency score (e.g., like 0.90) indicates that the outcome almost never occurs without that condition/configuration being present.

Sufficiency Analysis and Truth Table:

- The calibrated data is processed into a Truth Table, which lists all possible combinations of the IVs (e.g., Context AND Trait AND NOT Situation Pressure).
- fsQCA then determines which of these configurations are sufficient to produce the DV (Outcome).
- The Consistency Score for sufficiency is calculated using the same *ratio* of total overlap to total presence.
- Interpretation: This consistency score shows the degree to which a specific configuration consistently leads to the outcome.

Deriving the Configurational Effect (Solution Term):

- fsQCA uses Boolean algebra (Quine-McCluskey algorithm) to generate the most parsimonious solution—a set of logical, non-linear statements showing the simplest combinations of factors that are sufficient for the outcome.
- Example Solution: The results might show a pattern like: (High Context AND High Trait) OR (High Context AND NOT High Situation Pressure) are the recipes that lead to the Investment Decision outcome.
- Quantification of the Configurational Effect: The distinct, non-linear contribution is quantified by the Solution Coverage (the empirical relevance of the entire configuration) and Solution Consistency (the degree to which cases sharing the configuration consistently led to the outcome). These metrics quantify the overall strength and relevance of the synergistic relationship, which the correlation coefficient cannot capture.

Interpretation Guide

- Coverage ≥ 0.50
 - Configuration has real empirical relevance.
 - Consistency ≥ 0.80
 - Configuration is reliably sufficient.
 - Necessity ≥ 0.90
 - Outcome almost never occurs without the configuration.
- Lower readouts require caution.

Mandatory:

- Mandate CTRM Validation: Explicitly state that the Configurational Triad Rating Method (CTRM) steps, including the calculation of r1 (Intra-Configuration Coherence) and r2 (Global Conceptual Stability), must be completed before the fsQCA analysis can proceed. This ensures the necessary condition of r1 and r2 being high is met.

Reproducibility Notes

- This protocol is non-linear. Researchers must not:
 - perform regression substitution,
 - average configurational elements,
 - collapse fuzzy membership back to raw values.

Doing so breaks configurational logic.

Ethics and Dissemination

Ethical Considerations

- The protocol must be submitted to and approved by an Institutional Review Board (IRB) or Ethics Committee prior to any data collection. Informed consent will be obtained from all participants, ensuring they understand the non-traditional nature of the continuous scale measurement. Data must be anonymized or de-identified to protect participant confidentiality.

Scope of Ethical Approval: It is mandatory that the required IRB or Ethics Committee approval encompasses all human subjects research activities, including the foundational validity tasks of the Configurational Triad Rating Method (CTRM), such as expert rating for item understandability and distinctiveness, as well as the main participant data collection. This ensures strict adherence to all ethical and regulatory guidelines governing human subjects' research

Dissemination

- Results will be published in peer-reviewed journals. The complete, detailed protocol, including the non-linear statistical processing steps, will be made publicly available on protocols.io with a dedicated DOI to ensure transparency and maximize the replicability and reproducibility of the methodology.

We anticipate future psychometric evolution toward configurational modelling, particularly in executive coaching, clinical behaviour, autism assessment, and high-stakes decision environments

Limitations of Correlation in Psychometric Inference

- Traditional psychometric approaches by correlation-based inference, which assumes linearity, compensatory relationships among variables, and symmetric influence across levels of measurement. While effective for low-complexity constructs, these assumptions collapse when behavioural outcomes emerge from the co-presence of multiple interacting conditions. Correlation isolates variables, thereby obscuring configurational sufficiency, non-compensatory dynamics, and disjunctive causal pathways.

Synthesis

PHASE I: Configurational Validation (CTRM Protocol)

This phase establishes the foundational psychometric properties of the measurement tool.

Step | Action | Required Outcome/Metric

---|---|---

I.1. Design the Configurational Unit | Define the N distinct elements (e.g., Context, Situational Pressure, Trait) that form the configuration and the Dependent Variable (DV). | A clearly defined theoretical model (e.g., a Triad, Quadrad)

I.2. Item Creation and Parallel Sets | Develop a full item set to represent each element. Crucially, split the total item pool into at least two independent, theoretically parallel sets | Parallel item sets ready for administration.

I.3. Foundational Validity (Expert Rating) | Recruit Subject Matter Experts (SMEs) N Approximate 30 and conduct two tasks: | Item Understandability: High Interclass Correlation (ICC) (e.g., ICC = 0.785). Distinctiveness: High Mean Likert Rating (≥ 4.0 out of 5) and a statistically significant RM-ANOVA.

I.4. Elemental Reliability Check | Administer the full instrument to a large sample (N = 100+) and calculate Cronbach's alpha for the items within each single element (IV). | Expected Failure (Theoretical Success): A low α (e.g., α approx. 0.129) is required, confirming the elements are distinct formative indicators

I.5. Configurational Reliability Check | Calculate the two configurational coefficients using the composite scores from the main sample. | Intra-Configuration Coherence (r1): High value (e.g., 0.80), proving systematic alignment within the configuration. Global Conceptual Stability (r2): High value (e.g., 0.80), correlating Set A vs. Set B total scores, proving stability across item sets.

PHASE II: Data Collection & Preparation (CIAS Protocol)

This phase uses the validated instrument to collect raw data, focusing on continuous scoring and quality control.

Step | Action | Required Outcome/Metric

---|---|---

II.1. Verify CTRM Precondition | Mandatory Check: Confirm that Phase I has been successfully completed, with (r1) and (r2) achieving high values. | CTRM Validation Report must show (r1) and (r2) are high.

II.2. Item Pairing (Triad Formation) | Group the related items of each configurational element into triads (e.g., Context Item, Situational Pressure Item, Trait Item) under shared conceptual domains (e.g., Integrative Coherence). | Minimum 6 triads per participant.

II.3. Administration and Continuous Scoring | Present real or imagined situations and instruct participants to score each item using the free continuous scale of 0 (not applicable at all) to 100 (perfectly applicable). The Dependent Variable (DV) is also scored on this 0-100 scale | Raw continuous decimal values recorded for all IVs and the DV

II.4. Apply Stopping/Exclusion Rules | Discontinue administration if fatigue or identical/stereotyped patterns occur (e.g., 20% triads with identical values). Exclude data if quality control metrics are violated. | High-quality data set of raw 0-100 scores from $N \geq 25$ participants

PHASE III: Non-Linear Analysis (fsQCA Protocol)

This phase transforms the data and uses set-theoretic analysis to quantify the distinct configurational effect.

Step | Action | Required Outcome/Metric

---|---|---

III.1. Data Calibration (Fuzzification) | Transform all raw 0-100 scores (for both IVs and DV) into 0.0-1.0 fuzzy membership scores using an S-shaped function. | The three anchor points must be set: Full Non-Membership: 5 to 0.0; Crossover Point: 50 to 0.5. Full Membership: 95 to 1.0

III.2. Necessity Analysis | Test if any single IV or combination of IVs is a necessary condition for the DV (Outcome) | Necessity Consistency Score 0.90 indicates the outcome almost never occurs without that condition.

III.3. Sufficiency Analysis | 6 Solution Derivation | Process data into a Truth Table and use Boolean minimization (Quine-McCluskey) to generate the most parsimonious solution (combinations of IVs sufficient for the outcome). | Solution Term (e.g., High Context AND High Trait) and Solution Consistency

III.4. Quantify Configurational Effect | The distinct, non-linear contribution is quantified by the key fsQCA metrics. | Solution Consistency 0.80 (reliably sufficient) and Solution Coverage 0.50 (empirical relevance).

Glossary of Key Terms

Configuration

A non-linear combination of independent variables (e.g., Context, Situational Pressure, Trait) whose simultaneous presence creates a synergistic influence on the outcome. The effect is distinct from the additive contributions of the individual variables.

Formative Indicator

An item that contributes unique conceptual variance to a construct. In formative measurement, low internal consistency is expected because indicators are intentionally non-redundant. Removing items reduces conceptual breadth.

Membership Score (Fuzzy Membership)

A continuous value between 0.0 (full non-membership) and 1.0 (full membership) representing the degree to which a case belongs to a conceptual set (e.g., High Context). Derived through calibration of raw continuous scores.

Solution Coverage

A fsQCA metric indicating the empirical relevance of a sufficient configuration. Higher values reflect how much of the outcome space is explained by the configuration (recommended ≥ 0.50).

Solution Consistency

A fsQCA metric indicating the reliability of a sufficient configuration. High consistency means cases with the configuration almost always show the outcome (recommended ≥ 0.80).



Necessity (Necessary Condition)

A condition that must be present for the outcome to occur. A high necessity consistency score (≥ 0.90) indicates the outcome rarely appears without that condition.

Truth Table

A structured representation of all observed combinations of calibrated conditions. It forms the basis for Boolean minimization and sufficiency testing in fsQCA.

Boolean Minimization (Quine-McCluskey Algorithm)

A logical reduction procedure that simplifies multiple complex configurations into the parsimonious solution. Used to identify the simplest causal "recipes" for the outcome.

Additional Source:

Ramesh Kumar G S (2025): A Solution to the Reliability Paradox: The Configurational Triad Rating Method (CTRM) Procedure for Configurational Personality Assessment, Protocols.io. DOI:10.17504/protocols.io.14egnr14ml5d/v1