Behavioral Contingency Analysis

A formal symbolic language for the analysis of behavioral contingencies

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This presentation explains the main features of a symbolic language for codifying and analyzing behavioral contingencies and provides some examples of its applications.

Contents and Organization

INTRODUCTION

What are behavioral contingencies?

Behavioral contingencies state the *if-then* conditions that set the occasion for the *potential* occurrence of certain behavior and its consequences.

For example:

if **a certain party performs certain behavior,**
then **certain consequences may follow.**

Sometimes the desired meaning of "if" is "if and only if" and the desired meaning of "then," is "then and not otherwise."

If, then…

The *if* part of the statement is key, as a behavioral contingency can exist and be in effect without any of the specified behavior or any of its consequences ever occurring.

Examples of behavioral contingencies

- **If you drop the glass on the floor, it may break.**
- **If I pay for the product, I can take it home.**
- **If Joe extends his hand to her, Jill may shake it.**

Contingencies can be in effect
without anyone ever doing anything
and without anything ever happening.

Organisms are normally not aware of the operative behavioral contingencies

Every living organism is continuously subject to thousands of behavioral contingencies.

Behavioral contingencies are always present and operative, affecting our every operant act and movement, without our ever being aware of them, just as we are unaware of gravity or the air we breathe.

Names of behavioral contingencies

Many terms in our language refer to acts that create behavioral contingencies.

Acts that imply positive consequences:

propose, invite, suggest, offer, encourage, tempt, etc.

Acts that imply negative consequences:

warn, threaten, deter, mislead, deceive, blackmail, demand, entrap, seduce, entice, con, defraud, conceal, camouflage, disguise, tempt, etc.

Nouns corresponding to these verbs (advice, proposal, threat, invitation, warning, etc.), refer to the contingencies that are created.

Behavioral contingencies are involved in everyday interactions

Statements of the general type

"*If you do* A*, I will do* B,"

state behavioral contingencies

***Examples*: promises, enticements, requests inducements, demands, offers, threats.**

More elaborate, conditional, or qualified statements may refer to other parties, time periods, probabilities, and uncertainties.

Behavioral contingencies are at the root of the behavioral phenomena in:

- **Education and child management**
- **Economics**
- **Business and management**
- **Law**
- **Government and public affairs**
- **The rules of games**

In behavioral technology

Behavioral contingencies are the main tool in applications of behavior analysis including:

- **clinical interventions**
- **behavior modification**
- **educational technology**
- **organizational management**

Applications in education

Educational systems involve the behavioral contingencies for the interactions of:

- **teachers**
- **students**
- **parents**
- **administrators**
- **unions**
- **publishers**
- **members of the community.**

Applications in organizational management

Managers operate on behavioral contingencies when they seek to improve:

- **incentive compensation systems**
- **work flow systems**
- **safety practices**
- **communication systems**
- **quality control systems**

In Behavioral and Neurobiology Research:

A formal language for codifying behavioral contingencies helps specify independent variables precisely and unambiguously.

It can also help identify confounding variables that may otherwise be overlooked, as well as non-obvious parameters of independent variables.

Applications in law

Laws, as well as contracts, agreements, and treaties, consist, in general, of "*if, then*" statements of the form:

"If a party does or doesn't perform certain acts, certain consequences for that party shall follow."

The consequence can be behavior

In contingency statements, the consequence of the possible act can also be some behavior:

If Joe plays his drums at night,
the neighbors might complain.

If you feed the dog at the table during our meals,
he will often come begging during our meals.

If you park illegally, the cop may give you a ticket.

A statement need not be true to be a valid behavioral contingency statement:

"If you park illegally, you will always be towed away,"

though not true, is a valid behavioral contingency statement.

Distinguishing between behavioral contingencies and behavior

It is important to distinguish between two types of consequences:

(a) consequences caused by a possible act *within* a contingency, and

(b) consequences, including behavioral effects, caused by *the presence* of the contingency.

Distinguishing between acts and contingencies as causes of behavioral events

In a typical behavioral contingency statement,
the consequence of an act, if it occurs,
can be another behavioral event.

The presence of the contingency as a whole can be the cause of a different behavioral consequence.

Example:

Consider the contingency "*If Joe hits me, I will hit back.*"

The behavioral consequence of "*Joe hits*" is "*I will hit back*,"

The possible behavioral consequence of the presence of the *contingency as a whole is that Joe may refrain from hitting me*.

Empirical statements and behavioral contingency statements

Expressions that contain an →R term, as in S→R, are *empirical statements* about behavior.

An empirical statement is not a behavioral contingency statement.

The consequence of an act **A** *can be an empirical statement*

An empirically established phenomenon, like reflex elicitation, codified as $S \rightarrow R$, can be the consequence C of an experimenter's act A:

Example:

If the experimenter shines (act A) a light into the subject's eye, then the light (S) will cause the subject's pupil to contract (R).

Here the consequence C of act A would be the occurrence of the reflex $S \rightarrow R$.

Operant contingencies

An operant contingency statement cannot contain an S→ term, as stimuli or circumstances do not "cause" or "elicit" operant behavior—they merely set the occasion for it.

Acts are often ***occasioned*** by the presence of a stimulus because of the act's history of association with that stimulus.

The contingency language is able to codify this fact.

Contingency statements have causal status

The usefulness of contingency statements depends on the purity of their causal status—on their silence as to the behavioral effects they may generate. They must be formulated as "clean" independent variables whose effects, even when surmised, remain unstated.

This feature, based on the use of the "if" term, distinguishes the contingency language from most natural and technical languages, which normally conflate causes and effects. Terms like "stimulus," "response," "reinforcement," "reward," "punish," "extinction," "intend," "avoid," "escape," all imply cause-effect relationships.

Behavioral contingency statements can be predictive when combined with our knowledge of behavior

They can have predictive value when combined with our empirically-based knowledge of relationships between certain behavioral contingencies and certain behavioral phenomena.

Example:

***The behavioral contingency statement*:**

If act A, then positive consequence C.

***may lead us to predict that*:**

Act A may increase in frequency.

because we already know that acts that result in positive consequences often increase in frequency.

But the contingency statement by itself does not permit this prediction.

Practical usefulness of behavioral contingency analysis

The reason behavioral contingencies are of practical significance in the management of human affairs is that they can be manipulated.

Unlike the other major determiners of behavior, like personal histories and the realities of physics and biology, behavioral contingencies can be installed, modified, adjusted, and designed.

The need for a formal language

A formal symbolic contingency language, with an appropriate vocabulary, grammar, and syntax, can serve as a powerful tool for the application of behavioral contingency analysis.

A formal symbolic language can make behavioral contingency statements detailed and nuanced

Behavioral contingencies are rarely simple. We often need to specify:

- **the various parties that perform the various acts**
- **the attributes of the consequences**
- **the time relationships of acts and consequences**
- **which parties would perceive or predict the consequences**
- **and other details**

The complexity of behavioral contingencies

The complexity of any analysis reflects the level of detail at which the analyst wishes to penetrate the the contingencies being analyzed.

Advantages of formal languages over natural languages

- **Formal languages cut across all natural languages.**
- **They are succinct and avoid the ambiguities of verbal descriptions.**
- **They can reveal non-obvious relationships and regularities.**

ELEMENTS OF THE BEHAVIORAL CONTINGENCY LANGUAGE

Acts and consequences

A →

"***If*** act **A** occurs ***then*** … (a consequence)."

Every **A** is preceded by an implied "***if***."

The desired meaning of "if" is often

"if and only if"

and the desired meaning of "then," is often

"then and not otherwise."

The agent(s) of act A

aA means that **act A** would be performed by individual ***a***.

abA means that **act A** would be performed by both ***a*** *and* ***b***.

Agents of acts (cont.)

$aA_1 \rightarrow bA_2 \rightarrow$ is read as:

"*If* agent ***a*** performs act A_1 , and then *if* agent ***b*** performs *act* A_2 , then…"

Example: ***If you go through a red light, and then if a cop sees you, then…***

Note that the **A** can be replaced by **R** for response or by **B** for behavior, without affecting the language's grammar.

Consequence C

A→C means that **C** would be the consequence of act **A**.

Within the contingency statement, the consequence C can be a further act by the same agent or by another, resulting in a further consequence.

Further acts can be consequences

$aA_1 \rightarrow bA_2 \rightarrow C$ **can mean:**

"***If*** **agent *a* performs act A_1, the consequence could be that agent *b* would perform *act* A_2, with the further consequence C."**

Example: ***If a asks b to pass the salt, b may pass the salt, and then a would have the salt.***

This is equivalent to:

If a asks b to pass the salt, and if b then passes the salt, then a would have the salt.

Valence of a consequence C

Positive valence, C^+***, can mean***

beneficial, desired, positively reinforcing.

Negative valence, C^-***, can mean***

harmful, hurtful, aversive, punishing.

The term "valence," borrowed from chemistry and electronics, is needed to encompass positive and negative effects of consequences.

The affected party(ies)

The **party** or **parties** affected by the valence(s), are indicated in front of every plus or minus sign, like this:

$$C^{a+},\ C^{b-},\ C^{ab-},\ C^{a+,b-}$$

The valence, and the party(ies) affected by it, reflect the analyst's beliefs as to how the consequence would affect the parties.

"Agents," "parties," and "individuals"

The "agent" is the party

that may perform an act.

The term "party" designates individuals involved in the contingency in any way (e.g., affected by valences), not necessarily as agents of acts.

Time periods

T → C

means "upon termination of time T …"

A consequence can be delayed

by any length of time.

Example:

*If Joe puts (act **A**) the egg into boiling water,*

*it will be hard boiled (**C**) **ten minutes** (**T**) later.*

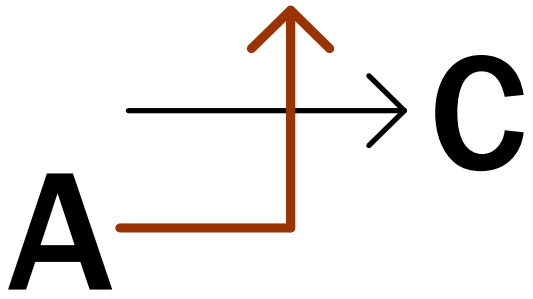
Consequences

A consequence **C** is any situation, event, or circumstance that could result from an **A**→ or from a **T**→.

Note that the **C** can be replaced by **S** for **S**timulus or **S**ituation, without affecting the grammar of the language.

Prevention

A vertical arrow cutting a horizontal arrow prevents the consequence represented by the horizontal arrow.



***Example*: If you step on the brake in time, you won't hit the pedestrian.**

***A bracket around vertically listed* As, Ts, *or* Cs**

indicates simultaneity. 

The order of listing has no significance:

$$\left[\begin{array}{l} C_1 \\ A \rightarrow C_2 \end{array}\right] \quad \text{means the same as} \quad \left[\begin{array}{l} A \rightarrow C_2 \\ C_1 \end{array}\right]$$

***Example*: The two contingencies listed in the above brackets go into effect simultaneously:**

"*If you see the pedestrian*" C_1 and
"*if you step on the brake* **A**, *then* C_2 *(the car will stop)*"

The three-term operant contingency

The traditional three-term operant contingency

$$S^D: R \rightarrow S^R$$

could be written in the contingency language as

$$\left[\begin{array}{l} S^D \\ R \rightarrow S^R \end{array}\right.$$

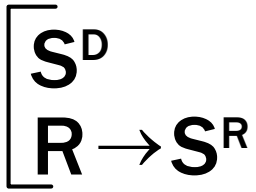
but this diagram would state a real behavioral contingency only if the S^D term is read as a stimulus

"that was previously correlated with R,"

or

"in the presence of which R was previously reinforced."

"S^D" is not part of the language



This diagram *would not* state a behavioral contingency if S^D is read as

"a stimulus that has a certain behavioral effect,"

The diagram would then be an empirical statement regarding the likelihood of certain behavior.

Since that is how the term "S^D" is commonly used, it is not part of the contingency language.

The meanings of C or S

In the contingency language,
the symbols C or S represent
only the prevailing situation and
circumstances, including all relevant
history factors, but imply nothing
about the C's or S's behavioral effects.

"C of A" and "C for A"

$$aA_1 \rightarrow \begin{cases} C_3 \\ bA_2 \rightarrow C_4 \end{cases}$$

means that C_3 would be a consequence of ***a***'s act A_1 and would also set the occasion (situation, **c**ircumstance) for ***b***'s act A_2.

Example:

If ***a*** smiles at ***b***, it creates the circumstance C_3 for ***b*** to smile back at ***a.***

Consequence and Circumstance

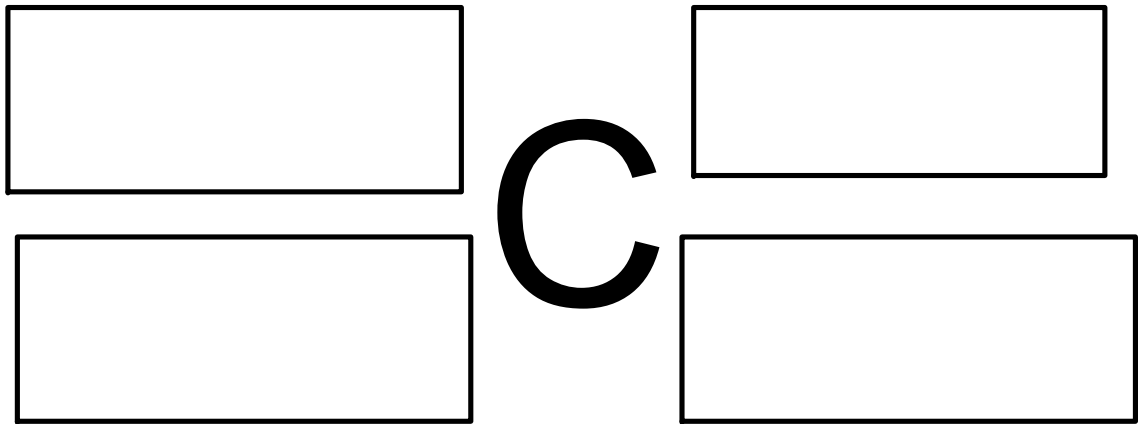
The symbol C can stand for either "Consequence" or "Circumstance" according to the desired emphasis.

Every consequence can be a circumstance (occasion) for other acts, and every circumstance is a consequence of prior acts or events.

The four quadrants for modifiers

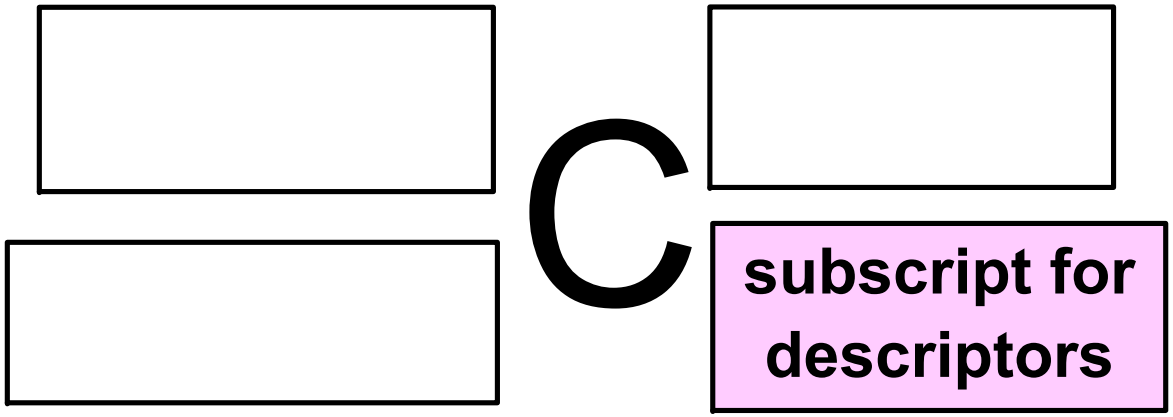
Every entity A, C, T, *a*, *M*, or *p* can have modifiers.

Modifiers are shown in the entity's four quadrants.



The lower right quadrant

The subscript provides a description or identification of the entity, sometimes indexed to a legend.



Subscripts as descriptors

Subscripts can be arbitrary numbers indexed to a legend:

$$A_1 \rightarrow C_2$$

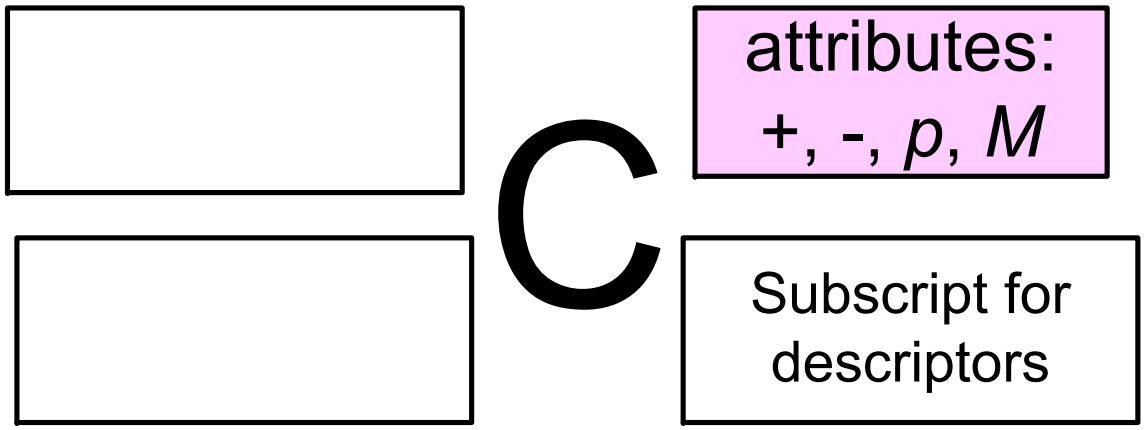
Legend: A_1—shoots, C_2—hits

Or, the entities can be described by words shown in the subscript position:

$$A_{\text{shoots}} \rightarrow C_{\text{hits}}$$

The upper right quadrant

The attributes + and - (these are possible valences), *M*, or *p* are shown in the upper right quadrant.



Attributes of entities

Attributes are indicated in an entity's upper right quadrant, like an exponent:

$$C^{+} \quad T^{v}$$

Entities can also have other attributes, (for example, a consequence may have an emotional quality for a party.)

Attributes of time intervals **T**

Duration $\mathbf{T}^{M}$

Variability $\mathbf{T}^{V}$

The probability attribute

$$C^{p}$$

Here *p* is the probability that consequence C would occur.

This probability reflects the analyst's belief and opinion.

The magnitude attribute *M*

A^{M} The *M* could refer to effort level, effectiveness, rate, frequency. It can also refer to duration, in which case *t* replaces the *M*. A^{t} is read as "end of act *A*'s duration."

$C^{(a+)^{M}}$ Here *M* refers to the magnitude of the positive valence for party *a*.

C^{M} The *M* attribute can refer to any scalable dimension of the consequence (e.g., loudness, amount of money).

Act duration

Acts like walking, running, waiting, foraging, working, or practicing a skill, often called activities, have durations *t*. Such acts may be repetitive or may continue or end at any time. A^t represents their termination points.

In behavior research, a latency or inter-response time would be codified as *t*, and its terminating event as A^t.

The analyst's perspective

All behavioral contingency statements, including the attributes of consequences, reflect the analyst's beliefs as to the conditions and contingencies that are in effect, the particular aspects of those conditions and contingencies on which he chooses to focus, and his beliefs regarding the parties.

Assigning a probability to the originating act A

It would be inconsistent and illogical to say "*If* A^{p} " in a contingency statement. If *p* were, say, 1.00, this would mean that the originating A will certainly occur, which is incompatible with saying "*If* A".

The same logical problem exists when the probability applied to the originating A is less than 1.00, as this would also be a statement about the likelihood of A.

A contingency statement states only what *can* happen —the logical possibility, not the likelihood, of the act.

Probabilities of subsequent acts by other parties

Therefore, $aA^p \rightarrow bA \rightarrow C$ would not make sense, but $aA \rightarrow bA^p \rightarrow C$ *would* make sense, because bA^p would be a consequence of aA.

"Perceive"

$_{a}\mathbf{C}$

means "party ***a*** would ***perceive*** consequence **C**."

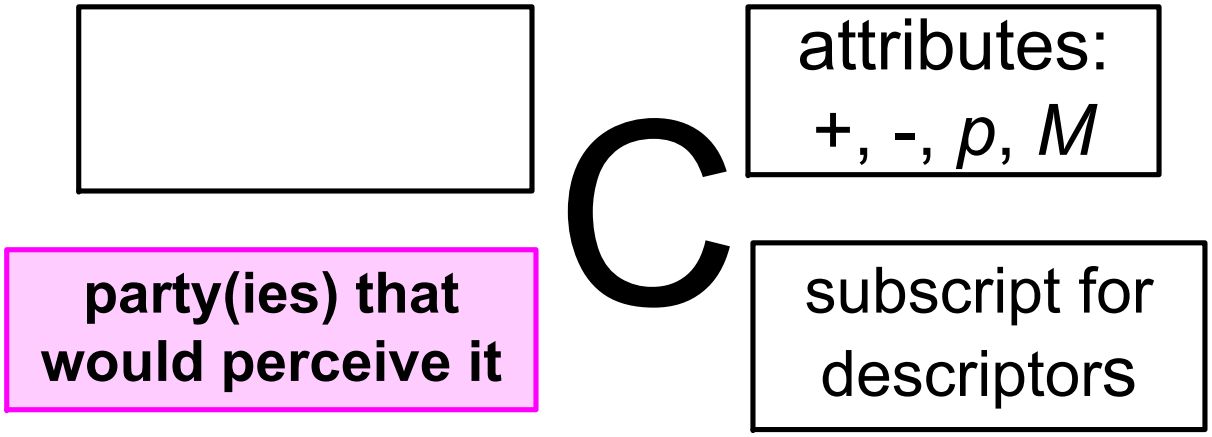
"perceive" **means "see," "hear," "notice," or "respond to."**

It can also mean "understand," as in *"perceive a meaning."*

The lower left quadrant

The lower left quadrant shows

the party that would *perceive* the entity.



Perceiving a consequence

$$ab\mathbf{A} \rightarrow_{ab} \mathbf{C}$$

The ***ab*** in the lower left quadrant of the **C** indicates that both of **A**'s agents ***a*** and ***b*** would *perceive* the consequence **C** of their joint act.

Perceiving an agent

$$_{b}aA\rightarrow$$

The ***b*** in the lower left quadrant of the ***a*** means that party ***b*** would ***perceive*** that the agent of **A** is ***a,*** and not someone else.

"Not perceive"

$$aA \rightarrow {}_{\tilde{a}b}C$$

Here the *a* has a tilde sign over it, meaning *"not a."*

This means that *a* would *not* perceive C but *b* would.

Examples:

- **If blind person *a* steps into the street (A),**
  he would *not perceive* the coming car (the C),
  but his seeing-eye dog *b* *would* perceive it.

- **If uncle *a* makes a hurtful comment A,**
  he would *not perceive* Mary's reaction (the C)
  but Mary's mother *b* *would* perceive it.

Misperceive

(as opposed to "*not perceive*")

$$abA \rightarrow a^{x}bC$$

a **would** ***misperceive*** **the C,**

and *b* would perceive it "correctly."

Example: **Suppose C is a nod by the person to whom *a* and *b* are speaking (A). *a* would *misperceive* the C as agreement, and *b* would perceive it "correctly" to mean "I hear you."**

Explaining a misperception

$$A \rightarrow a_1^x C_2$$

The C_2 in the diagram is what the analyst believes would *actually* occur.

The subscript can explain what *a* would (mistakenly) perceive instead.

Legend:

C_2 a nod

a^x_1 misperceives the nod as agreement

Possible meanings of a^x

There are many possible kinds of misperception:

Perceiving an entity as differing from reality or from the analyst's belief.

Idiosyncratic subjective perceptions: e.g., beautiful, unacceptable, threatening, dangerous, comfortable, embarrassing, valuable, worthless, etc.

The formal language does not distinguish between different kinds of misperception.

Explaining the misperception

The specific nature of ***a***'s misperception

can be explained in a legend

under an arbitrary subscript numeral, like "5."

$$\mathbf{A} \rightarrow a^{x}_{5}\, b\mathbf{C}$$

Examples:

a_5 misperceives an innocent question (as hostile).

a_5 misperceives a rabid dog (as healthy).

a_5 misperceives an overpriced stock (as being cheap).

Perceiving and misperceiving the agent of an act

$_{b}aA$ — ***b*** would perceive that ***a*** is **A**'s agent

$_{b^{x}}aA$ — ***b*** would ***misperceive*** the fact that ***a*** is **A**'s agent

Examples:

- False accusations
- Misperceiving the giver of a gift

Misperception of time periods

$$a^x T$$

means that *a* would misperceive T.

***Example**: **a** would respond to the time interval as if it were longer or shorter.*

Time discrimination is involved in self-management, self-control, temporal discounting, etc.

"Predict"

A party's prediction of a consequence can be the result of prior contact with similar contingencies and consequences.

Prediction is based on history

A history may be communicated by a signal whose effect is due to its history of association with the situation and the contingency.

Contingencies that involve verbal individuals are often communicated by verbal signals and statements.

Choice of the term "predict"

The behavioral contingency language requires a term meaning

"all of the effects of a history of exposure to similar contingencies, circumstances, or stimuli, or of information regarding these, which may affect the individual's behavior with respect to the consequence."

The terms "predict," "anticipate," "expect," and "project" all have some baggage of undesired connotations.

"Predict" was chosen because it has the fewest.

The terms "misperceive" and "mispredict"

The term "*mispredict*" means "behaving in accordance with a history of exposure to contingencies, circumstances, or stimuli other than those that would be in effect."

Similarly, the term "*misperceive*" means "seeing, noticing, hearing, or understanding in a manner that reflects a history with respect to circumstances or stimuli other than those that would be in effect."

Notation of "predict"

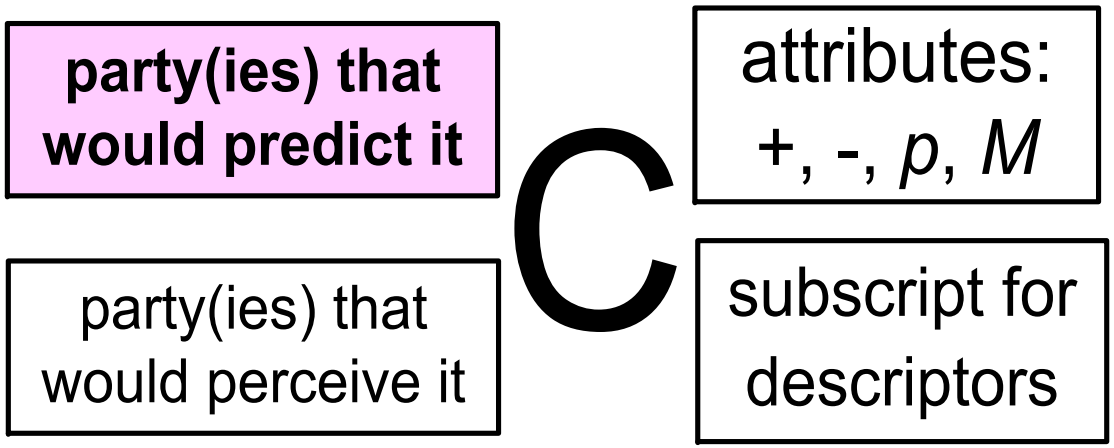
$$\mathbf{A} \rightarrow {}^{a}\mathbf{C}$$

means that ***a*** would ***predict*** **C.**

The ***a*** is in the **C**'s

upper left quadrant.

The upper left quadrant shows the party that would predict the entity



"Predict" and "perceive"

$$aA \rightarrow \begin{matrix} a \\ a \end{matrix} C$$

a would ***predict*** **C** and would also ***perceive*** it when it occurs.

Perceiving the mispredicted consequence:

Being surprised

a would ***mispredict*** **C** and would ***perceive*** the *actual* consequence if and when it occurs.

$$aA \rightarrow \begin{matrix} a^{x} \\ a \end{matrix} C^{a-}$$

Example:

aA **– dialing a wrong phone number.**

a would mispredict **the number actually reached and** ***would perceive*** **that he dialed a wrong number.**

"Not predict"

$$A \rightarrow \tilde{a}C$$

Here the *a* has a tilde sign over it, meaning "*not a,*" *a* would *not predict* C.

Example: ***a*** **would *not predict* that his car's battery would die when inadvertently leaving his car lights on.**

Predict without perceiving

$$aA \rightarrow \begin{matrix} a \\ \tilde{a} \end{matrix} C$$

Examples:

- **Suicide**. One would ***predict*** the consequence but ***not perceive*** it.
- One may ***predict*** but ***not perceive*** the consequence of sending an e-mail

Codifying the operant contingency

The verbs *perceive* and *predict* are key to the formal codification of the operant contingency.

Codifying the operant contingency —the consequence must be perceived

$$\left[\begin{array}{l} aA \rightarrow {}_aC_2 \\ C_1 \end{array}\right.$$

The diagram states that *a* would *perceive* C_2 and is a statement about *a*'s biology, history, about the C_2 in question, and about the prevailing circumstances C_1.

If the diagram stated that *a* would *misperceive* C_2, the meaning would be that *a* would perceive *some other* consequence, as in an optical illusion.

If it stated that *a* would *not perceive* C_2, the reason could be that C_2 is obstructed, out of range, or outside *a*'s perceptual experience.

Codifying the operant contingency—behavior that is a function of its (past) consequences

$$\left[\begin{array}{l} {}_{a}A \rightarrow {}^{a}_{a}C_2 \\ C_1 \end{array}\right.$$

The diagram states that *a* would *predict* C_2 on the basis of *a*'s history with respect to act A's past consequences in circumstances similar to C_1.

If the diagram stated that *a* would *mis*predict C_2, the meaning would be that *a* would behave as if act A would result in a consequence *other than* the analyst's belief regarding C_2.

Distinguishing between perceive and predict

Most natural languages make extensive use of terms like "know that," "realize that," and "aware that."

Such terms do not distinguish between "*perceive*" and "*predict*."

In analyzing contingencies, the distinction is important.

Overcoming ambiguity while expressing fine nuances

The "*predict*" and "*perceive*" modifiers are key to overcoming some of the ambiguities inherent in any natural language.

At the same time, they provide the means for codifying the myriad nuances that natural languages can express.

Signals that cue predictions

A signal (or circumstance) that might cue a party's prediction of a consequence has the status of a C.

Such a C may be a situation or circumstance consequated by an external agency *e* or by another party.

Examples of externally consequated Cs:

- **C: The hand that a bridge player was dealt**
  e: ***the card dealer who dealt the bridge hand***

- **C: a test item presented to a test taker**
  e: ***the presenter of the test item,***
  or the student turning the page.

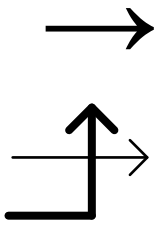
- **C: a situation due to the physical environment**
  e: ***the physical environment (e.g., weather, terrain)***

- **C: a prevailing rule**
  e: ***the promulgator of the rule***

THE RECURSIVE SYNTACTIC STRUCTURE

The syntactic structure

- ***Nouns***: **A, C, T**, **and** ***letter designators of the involved parties.***
- ***Verbs***:



consequate

prevent

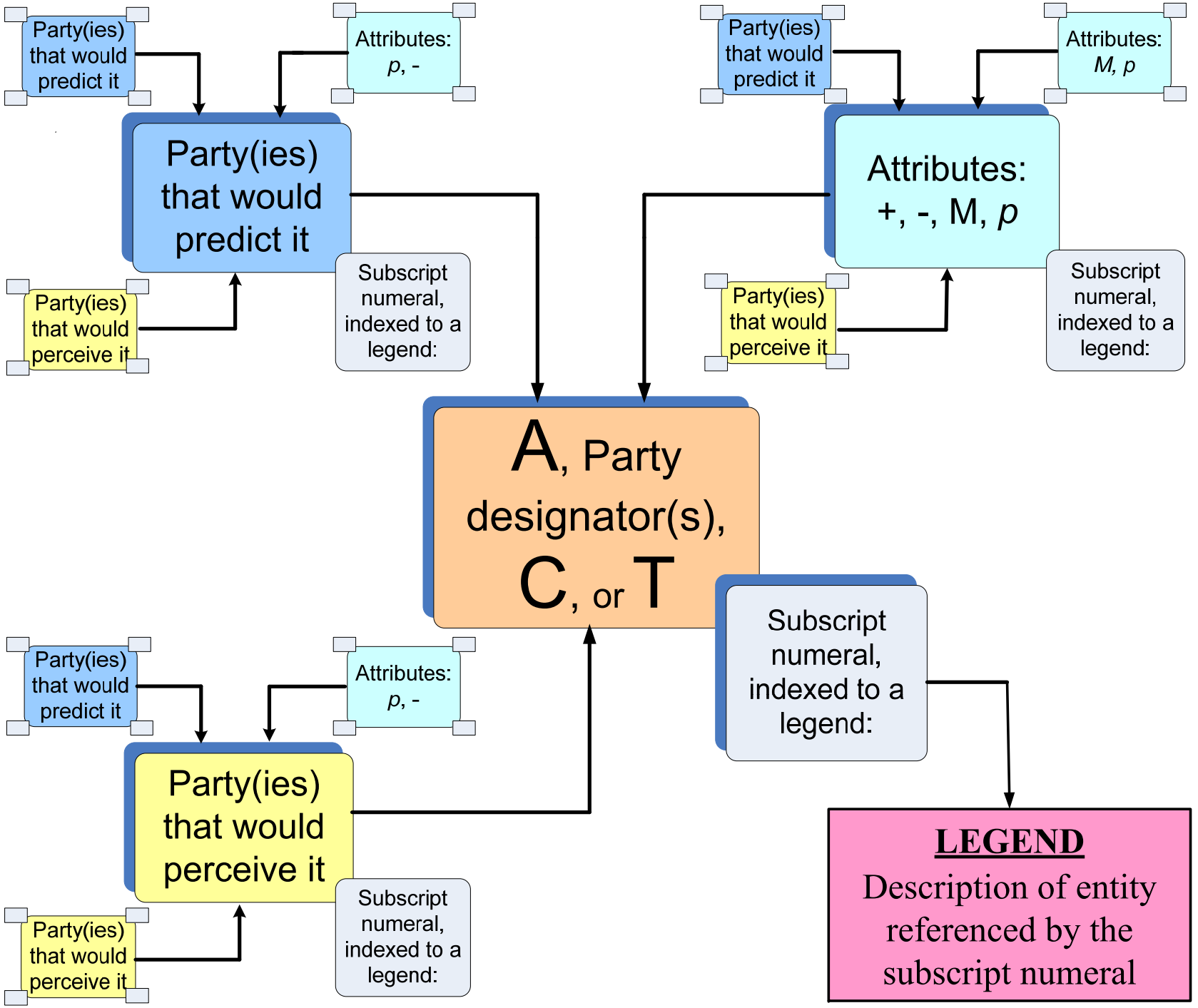
predict

perceive

- ***The parties that predict and perceive can modify any entity.***
- ***Attributes***: *Probability* ***p***, *magnitude* ***M***, *valence* **+** *or* **–** *for a party. The* **x** *and* **~** *are possible attributes of* ***predict*** *and* ***perceive.***

The four-quadrant recursive structure of the language

The chart that follows shows that each entity (noun, verb, attribute, modifier, etc.) can, in turn, be modified by any of the same modifiers in its own respective four quadrants.


Party(ies) that would predict it
Attributes: p, -
Party(ies) that would predict it
Party(ies) that would perceive it
Subscript numeral, indexed to a legend:
Party(ies) that would predict it
Attributes: M, p
Attributes: +, -, M, p
Party(ies) that would perceive it
Subscript numeral, indexed to a legend:
A, Party designator(s), C, or T
Subscript numeral, indexed to a legend:
Party(ies) that would predict it
Attributes: p, -
Party(ies) that would perceive it
Party(ies) that would perceive it
Subscript numeral, indexed to a legend:
LEGEND
Description of entity referenced by the subscript numeral

The language's versatility and reach

This quadrant grammar, with the fractal-like infinite regresses of levels of quadrants of quadrants, makes the four-noun, four-verb vocabulary sufficient for the codification of the subtlest nuances.

Misperceiving a valence

a **would perceive C correctly and *misperceive* its valence.**

$$A \rightarrow {}_{a}C^{a^{x}(a-)}$$

Examples:

- Adam and Eve might perceive the apple **C** correctly, but *misperceive* its negative valence (***a***-) for them.
- One might perceive a painting or stamp accurately, but *misperceive* its value, the value being the valence.
- A legislator may perceive a piece of legislation accurately, but *misperceive* its valence for his constituents.

Misperceiving the magnitude of a valence

$$A \rightarrow {}_{a}C^{(a+)}\ a^{x(M)}$$

Here magnitude *M* is an attribute of the valence.

a **would perceive the consequence C**

but would *misperceive* *M*.

Example: **If *a* found the lost emerald C,**

a **would perceive the emerald**

but would misperceive its value.

Different perceptions of the valence

$_{a}C^{a-}$ ***a*** would perceive both **C** and its valence

$_{a}C^{a^{x}(a-)}$ ***a*** would perceive **C** and misperceive its valence.

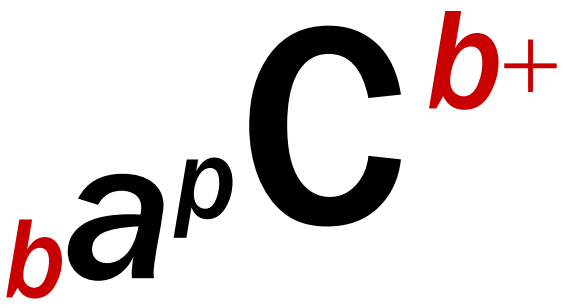
$_{a^{x}}C^{a-}$ ***a*** would misperceive both **C** and its valence.

$_{a}C^{\tilde{a}a-}$ ***a*** would perceive **C** but not its valence.

$_{\tilde{a}}C^{a-}$ ***a*** would not perceive either **C** or its valence.

Example of distributivity

b would perceive that ***a*** would probably (with probability ***p***) perceive **C** and its attribute ***b***+.



Codifying nuances of meaning

If ***a*** issues a request ${}_{b}\mathbf{C}_4$ to ***b*** to do $\mathbf{A}_2$,

then if ***b*** does $\mathbf{A}_2$, the consequences

would be $\mathbf{C}_3$ and $b\mathbf{A}_2$.

Would ***a*** predict that ***b*** will comply and do $\mathbf{C}_3$?

The answer can have many nuances

(See next slide).

$$a\mathbf{A}_1 \rightarrow \begin{cases} b\mathbf{A}_2 \rightarrow \mathbf{C}_3 \\ {}_{b}\mathbf{C}_4 \end{cases}$$

Nuances of meaning regarding bA_2

- $^{a}(bA_2)$ ***a*** would predict bA_2
- $^{a?}(bA_2)$ The analyst is uncertain that ***a*** would predict bA_2.
- $(bA_2)^{p}$ The probability of bA_2 occurring is less than one.
- $b^{p}A_2$ ***p*** is the probability that ***b*** would be the agent of A_2.
- Replacing the ***a*** in $^{a}(bA_2)$ with a^{p} means that the analyst considers the probability to be ***p*** that ***a*** would predict bA_2.
- $\tilde{a}$ in lieu of ***a*** in the notations described above would provide another dimension of nuances.

Codifying "theory of mind" contingencies

"Theory of mind" contingencies usually involve one party's perception or prediction of another party's perception or prediction of a consequence or of the valence of the consequence.

For example: **Party *a* may perceive or predict that party *b* may perceive or predict that *a* would misperceive or mispredict the consequences of *b*'s behavior.**

The behavioral contingencies that set the occasion for most "theory of mind" phenomena therefore require the concepts of *perceive* and *predict*, often with recursive levels of regress.

Example of a "theory of mind" contingency

If Joe wanted to snoop on his sister Mary's diary, but Mary wouldn't want him to, Joe may act or talk in ways that Joe predicts may cause Mary to misperceive the positive valence for him of reading the diary, resulting in her leaving the door to her room unlocked, enabling Joe to enter her room and read her diary.

If Mary perceived Joe's deception, she would lock the door to her room.

Codifying "theory of mind" situations

- **perception and/or prediction of others' intentions**
- **perception and/or prediction of another's attention**
- **perception of another's misprediction ("false belief")**
- **prediction and/or perception of others' predictions and/or perceptions with the potential for additional recursive levels.**

Example: **Autism can involve deficiencies in the ability to perceive or predict what others would perceive, predict, or experience (e.g., the valence).**

EFFECTS OF THE ANALYST'S FOCUS

Significance of behavioral history factors

The analyst's characterization of any situation represented in a contingency diagram reflects his focus and knowledge of the situation and of the parties' histories and motivations.

The characterizations may be different for different parties, and for the same parties at different times.

Importance of the analyst's focus

The specification of the acts A, the time periods T, the consequences C, the *parties* involved, and the probabilities and magnitudes, *reflect the analyst's focus and view of the situation*.

Such modifiers as *perceive, predict*, and the *valences* of consequences *reflect the analyst's knowledge or beliefs about the parties*.

Simplifying assumptions

Behavioral contingency diagrams, like all formal symbolic statements, always reflect simplifying assumptions that omit features the analyst considers relatively less important.

The diagrams bear the same type of relationship to real-life contingencies that a drawing of an object bears to the real object.

A common simplifying assumption: Omission of time lags

Time lags **T** intervene between
every act **A** and its consequence **C**.

When the analyst considers the time lag relevant, the contingency would be shown as ***A*→*T*→*C***.

When the analyst *does not* consider it relevant, the **T** would not be shown.

The Ts would be shown only when the time lags are important for the aspects of the contingency on which the analyst wishes to focus.

Abbreviations:
Another way to simplify diagrams

The symbol C^{a+} is an abbreviation.

The unabbreviated diagram might elaborate the reasons for the valence being positive for ***a***.

Examples of elaborations:

- ***a*** might be able to avert an impending negative consequence.
- Certain further acts by ***a*** might procure a positive consequence.

THE GRAMMAR OF CONSEQUENCES

The grammar of consequences

The default feature is that only one consequence C is present at one time, because every C is presumed to include all of the relevant features of the situation.

Thus any change of C_1 is a new, again all-inclusive, C_2 produced by a further A or T.

$$A \rightarrow \begin{cases} T \rightarrow C_2 \\ C_1 \end{cases}$$

Multiple consequences

All acts have multiple and innumerable consequences.

The act's agent would never be able to perceive or predict all of these.

Example:

If I open the refrigerator and pour myself some juice, I may predict that I would be drinking juice in a few seconds and that I would then rinse out my glass.

I would not perceive or predict all of the physical, chemical, and thermal consequences of opening and closing the refrigerator or the effects of the juice on my stomach chemistry.

Weightier examples of multiple consequences

- If a company's board of directors closes down a factory, they may predict certain consequences but not others.
- **If a government passes a new law, they will predict some consequences and not others.**
- **If the leaders of a country start a war, they predict some consequences and not others.**

Diverse consequences

When the modifiers of the consequences are heterogeneous and yet relevant, more than one C is needed.

Examples of diverse consequences

Party *a* introduces two parties *b* and *c* to each other.

(1) ${}_{b}\mathbf{C}_{2}$ (***b***'s perception of the situation that includes party ***c***),

(2) ${}_{c}\mathbf{C}_{3}$ (***c***'s perception of the situation that includes party ***b***).

Also, $\mathbf{C}_{2}$ and $\mathbf{C}_{3}$ may have different valences for ***b*** and ***c***, and the three parties ***a***, ***b***, and ***c*** may have different predictions and/or perceptions of those valences.

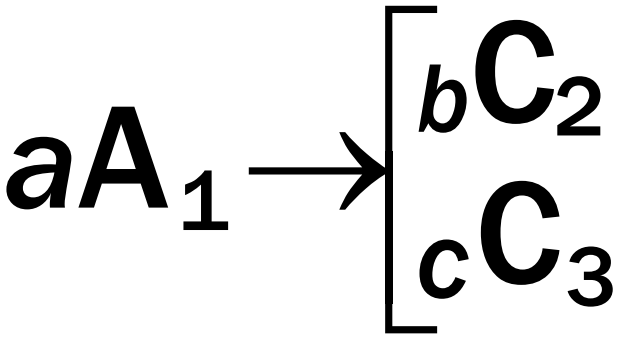
(Note: As always, the vertical order has no significance).

$$a\mathbf{A}_{1} \rightarrow \begin{bmatrix} {}_{b}\mathbf{C}_{2} \\ {}_{c}\mathbf{C}_{3} \end{bmatrix}$$

Another example of diverse consequences

A business executive *a* assigns a task to *b* and *c*.

When ***b*** and ***c*** divide the work and each one does a different part, the consequence for each one would be different.



A consequence can be the sight of an act being performed

When the consequence ${}_{b}\mathbf{C}_{2}$ of ***a***'s act $\mathbf{A}_{1}$ serves as a cue for ***b***, ${}_{b}\mathbf{C}_{2}$ can be defined as just the sight of ***a*** performing $\mathbf{A}_{1}$, as perceived by ***b***.

${}_{b}\mathbf{C}_{2}$ then serves as the cue for $b\mathbf{A}_{3}$

$$a\mathbf{A}_{1} \rightarrow \begin{bmatrix} {}_{b}\mathbf{C}_{2} \\ b\mathbf{A}_{3} \rightarrow \mathbf{C}_{4} \end{bmatrix}$$

Acts and their consequences can have different modifiers

The analyst may want to distinguish between perception/prediction of the act itself, and of the act's consequence.

Example: Party ***b*** would perceive $\mathbf{A_1}$ being performed but not its *consequence* $\mathbf{C_2}$.

$$a_b\mathbf{A_1} \rightarrow \begin{cases} \tilde{b}\mathbf{C_2} \\ b\mathbf{A_3} \rightarrow \mathbf{C_4} \end{cases}$$

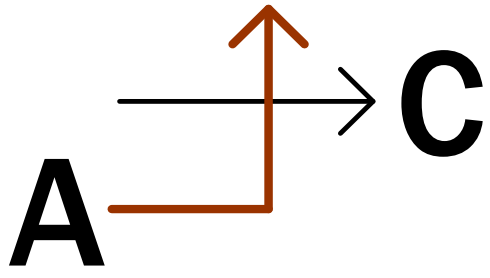
If ***b*** and the $\tilde{b}$ were reversed, ***b*** would perceive the *consequence* $\mathbf{C_2}$ but not $\mathbf{A_1}$ being performed.

PREVENTION CONTINGENCIES

Prevention

A vertical arrow cutting a horizontal arrow
terminates the contingency represented by the horizontal arrow.

It prevents the consequence and creates a new one.



Example:

If you feed the hungry horse, it will not die.

Consequence of omitting an act

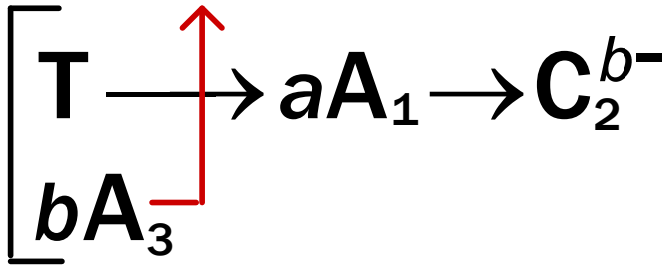
The consequence of omitting an act can be significant.

Example:

If a phone bill is not paid by the end of time T, the phone company will shut off service.

Consequence of omitting an act

Here, if A_3 is omitted, the C^{b-} would be the result of A_1 after the termination of T→



Legend:

1. The phone company (*a*) cutting off service C^{b-}_2 after time T.
2. Service cut off.
3. Party *b* paying (A_3) the phone bill

Omitted acts

Many common contingencies involve "omitted" acts. Omitted acts are of interest when the focus is on the consequence of the omission.

We say that an act is "omitted" when its occurrence could avert a consequence.

The consequence would usually be the result of an act A by another (sometimes external) party, or of the termination of a time period T.

An omitted act is never codified as an act A.

Obligations

Obligations are acts whose omission can result in a negative consequence.

a **may be obligated to make payments on a car loan, on an insurance policy, mortgage payments, property tax payments, or to provide food and shelter to an animal.**

Negative consequences of non-performance

An obligation is an act that *a* must perform to avert a negative consequence.

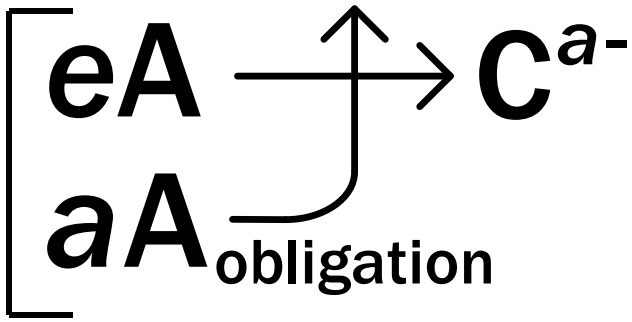
The negative consequence may be the result of acts by others, or of the passage of time.

Examples of negative consequences:

A lender repossessing the car.
A mortgage company foreclosing.
A pet running away or dying.
A tax authority attaching the property.
The electricity being shut off.

Codification of the obligation contingency

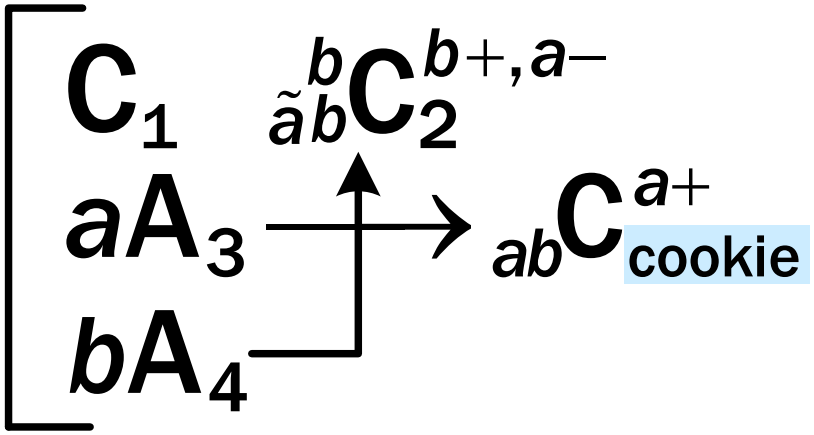
Here eA represents acts by external agents, like governmental (e.g., tax) authorities, or nature.



If the obligation is fulfilled, C^{a-} is averted.

Vertical arrows that terminate and change contingencies

If ***b*** takes the cookie out of ***a***'s lunch box (bA_4) before ***a*** has done so, ***a*** would be prevented (vertical cutting arrow) from taking it (aA_3).

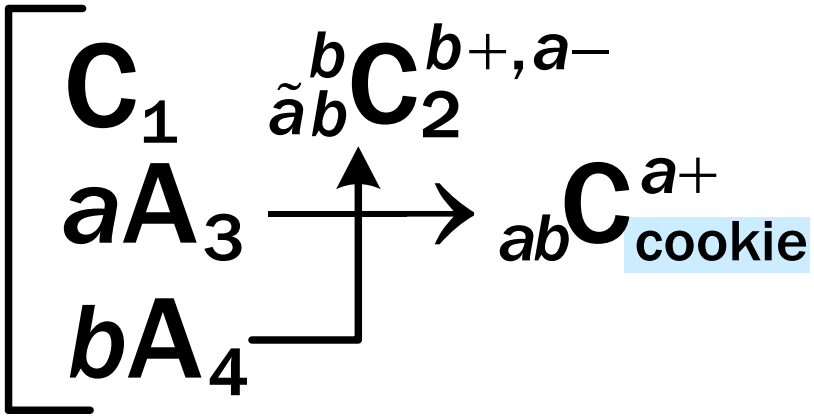


Definition of a theft

If both ***a*** and ***b*** would predict that the cookie will end up in ***b***'s possession (C_2), both would be shown in the upper left quadrant of C_2 rather than just ***b*** as in the diagram.

If both ***a*** and ***b*** were pre-subscripts as in ${}_{ab}C_2^{b+,a-}$, both would perceive that ***b*** would now have the cookie.

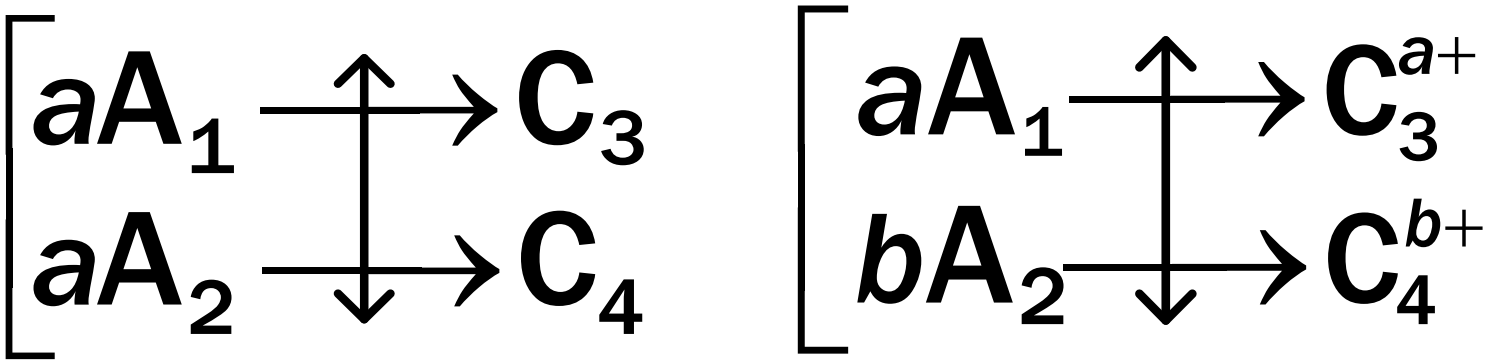
Since only ***b*** is shown as the pre-subscript, and ***a*** is shown with a negation sign, ***ã***, bA_4 can represent a theft.



Reciprocal vertical arrows: Decision making and competition

Reciprocal vertical arrows show that either act would preclude the other.

Left: ***a*** making a decision or choice.



Right: If ***a*** and ***b*** compete in a zero sum game, once ***a*** has achieved C^{a+}, ***b*** can no longer achieve C^{b+}, and vice versa.

Reciprocal vertical arrows are an abbreviation

This abbreviation simplifies the diagram so as to highlight the essential elements.

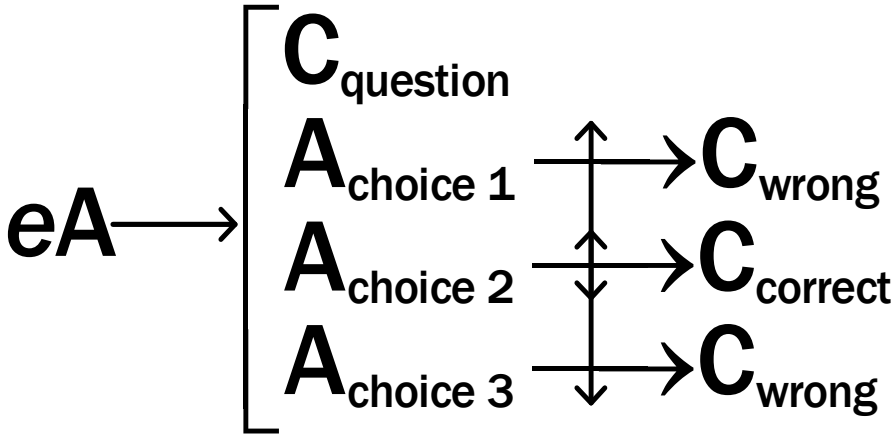
The unabbreviated, messier way, would show two separate vertical arrows, each one originating from one of the two events, and cutting the horizontal arrow of the other.

Simultaneous multiple discrimination: Answering a multiple choice item

When taking a multiple choice test, the student may confront a question C to which he can respond with one of three acts (choices).

The external agency *e* that presents the question may be a teacher, a computer, or the student himself turning a page. If *e*A consequates the question C, the student can check one of the three boxes.

The reciprocal vertical arrows show that each of the three choices terminates the availability of the others.



DECEPTION AND ENTRAPMENT

Predicting and mispredicting a consequence

$$aA \rightarrow {}^{b}C^{a-}$$

b would *predict* that ***a*** would hurt himself.

$$aA \rightarrow {}^{a^{x}}C^{a-}$$

a would *mispredict* that he would hurt himself.

Mispredictions

Getting swindled, wrong number, "friendly fire"

The actual consequence may differ from the one that *a* would predict:

$$aA \rightarrow {}^{a^x}C^{a-}$$

The a^x in the C's upper left quadrant shows that *a* would mispredict C^{a-}.

***Examples*:**

Dialing a phone number in error.

"friendly fire" – mistakenly shooting one of his own men.

Perceiving the mispredicted consequence

The ***a*** in the lower left quadrant of the **C** shows that ***a*** would *perceive* the *actual* consequence if and when it occurs.

$$aA \rightarrow {}^{a^x}_{a}C^{a-}$$

Examples:

- ***a*** would perceive that he dialed an incorrect phone number.
- ***a*** would perceive that he mistakenly shot one of his own.

Perceiving a misprediction

$$\mathbf{A} \longrightarrow {}_{b}\mathbf{a}^{x}\mathbf{C}^{a-}$$

Here ***b*** would *perceive* that ***a*** would mispredict $\mathbf{C}^{a-}$. The ***b*** modifies the $\mathbf{a}^{x}$.

Example: ***b*** would *perceive* that ***a*** would walk into a trap.

Deception and its manifestations

Deception is a basic biological function.

Examples:

- **Hiding and concealing**
- **Mimicry**
- **Trickery**
- **Seduction**
- **Pretense and feigning**
- **Diverting attention**
- **Camouflage**

Contingency analysis of deception

b **is said to be *deceived* if it would *misperceive* or *mispredict* a consequence or circumstance C.**

Misperceive:

$$A \rightarrow {}^{b^x}C$$

Mispredict:

$$A \rightarrow b^x C$$

Notation of intentionality

When the act's agent would *predict* the act's consequence, one would say that the action is "*intentional*."

$$aA \rightarrow {}^{a}C$$

***Example**: If the shooter **a** would predict that the bullet would hit the man, the shooting is considered "intentional".*

If the shooter would not predict it, the shooting would be considered "unintentional".

The concept of "intent"

The contingency language expresses the concept of "***intent***" fully as:

Act A's agent *predicts*

the act's consequence C.

The consequence may be modified by attributes like probability or delay when the analyst wants to focus on those features.

Terminology:

The terms ***"intentional," "intend," "expect," or "anticipate"*** are therefore not needed and are not part of the formal language.

Intentional deception

An act is ***intentionally deceptive*** if its agent ***a predicts*** that another party ***b*** would ***misperceive*** or ***mispredict*** the consequence. (Note the ***a*** in the ***b***' s upper left quadrant).

$$aA \rightarrow {}^{a}b^{x}C$$

Forms of intentional deception

Here *a* is the deceiver and *b* is the deceived.
In both diagrams, *a predicts* that *b* would *perceive* C.

$$aA \rightarrow {}_{a}{}_{b}C \; {}^{a}b^{x}(b^{-})$$

Here ***b*** would ***misperceive*** the **C**'s ***negative valence***.

$$aA \rightarrow {}_{a}{}_{b}C \; {}^{a}b^{x}(b^{-})$$

Here ***b*** would ***mispredict*** **C**'s ***negative valence***.

Harm to the deceived party

***Harmless deception*:**

Parent tells child Santa Claus will come.

An optical illusion deceives a perceiver.

***Harmful deception*:**

Frauds, cons, thefts, trickery, bluffing

$$aA \rightarrow {}^{a}b^{x}C^{b?}$$

(***a*** is the deceiver and ***b*** is the deceived party).

Direct and contingent deception

Direct deception: $aA \rightarrow {}^{a}b^{x}C^{b-}$

Contingent deception: **Setting the occasion C_1 for the deceived party *b* to perform an act whose consequence C_2 *b* would *mispredict*:**

$$aA \rightarrow \begin{cases} {}_{a}b\,C_1 \\ bA \rightarrow {}^{a}b^{x}C_2^{b-} \end{cases}$$

Disguising a situation, misrepresenting facts, hiding a danger

b **would normally perceive** C^{b-}**, but if** ***a*****A**,

b **would** ***not perceive*** C^{b-} **(Note the** $\tilde{b}$ **).**

Thus ***a*** **prevents** ***b*** **from perceiving** C^{b-}**.**

$$\left[\begin{array}{l} {}_{b}C^{b-} \\ aA \rightarrow {}^{a}\tilde{b}C^{b-} \end{array}\right.$$

Impersonation

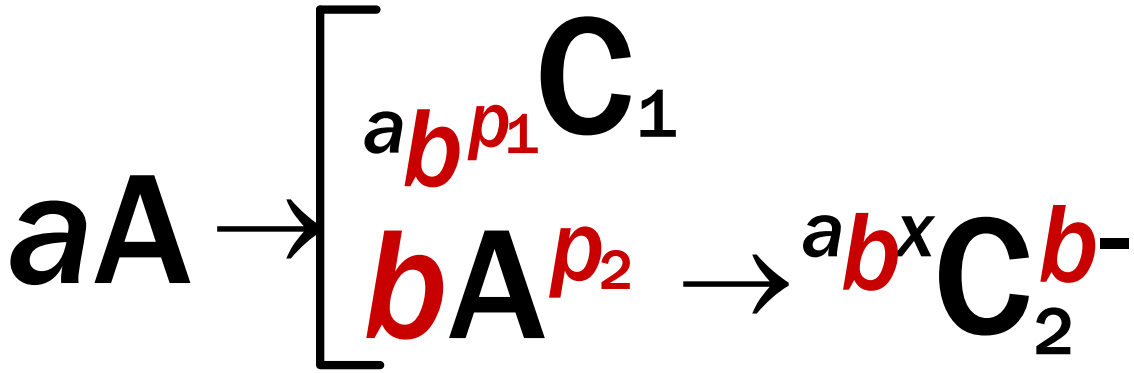
Here ***a*** performs an act $\mathbf{A}_1$ that causes ***b*** to misperceive the agent of ***a***'s act(s) $\mathbf{A}_2$ as someone other than ***a***, and ***a*** predicts ***b***'s misperception.

$$\boldsymbol{a}\mathbf{A}_1 \rightarrow {}_{\boldsymbol{a}}\boldsymbol{b}^{\boldsymbol{x}}\boldsymbol{a}\mathbf{A}_2$$

***Example*: A suicide bomber dons a friendly uniform.**

Deceptive advertisement

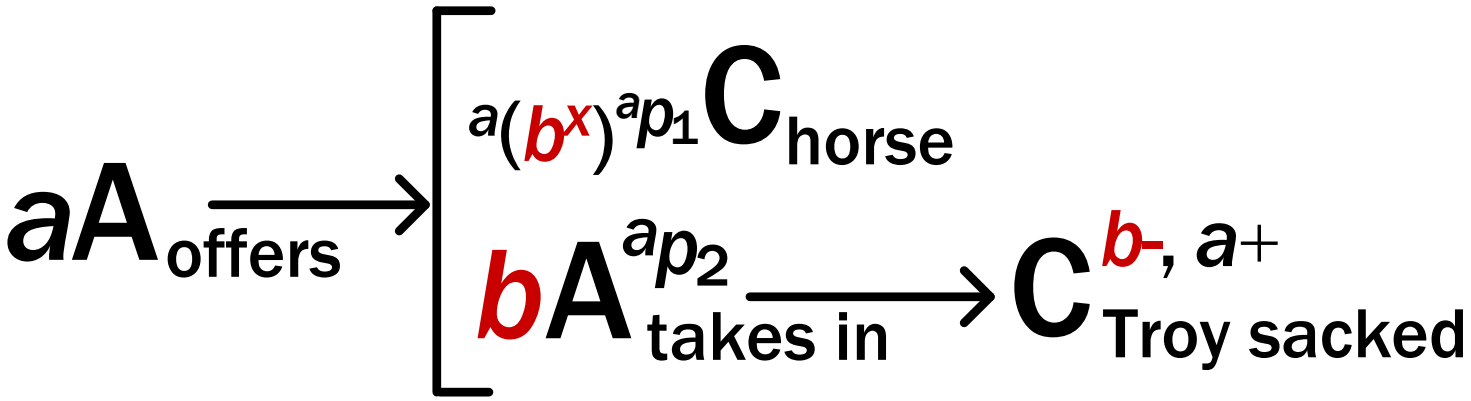
This is the contingent deception contingency, where *probabilities* are attached to *b*'s perception of C_1 and to *b*'s response A to it.



Trickery (Trojan horse)

Odysseus conceived the following deception:

If we (*a*) build a giant hollow wooden horse and leave it for the Trojans (*b*) to find, they may *misperceive* the horse (as being empty rather than filled with our soldiers) and take it into Troy.



Selling a counterfeit

Both ***a*** and ***b*** perceive $\mathbf{C_3}$ accurately, but ***b*** ***misperceives*** attribute M_4 of $\mathbf{C_3}$. M_4 can represent value or some other attribute ***b*** might care about.

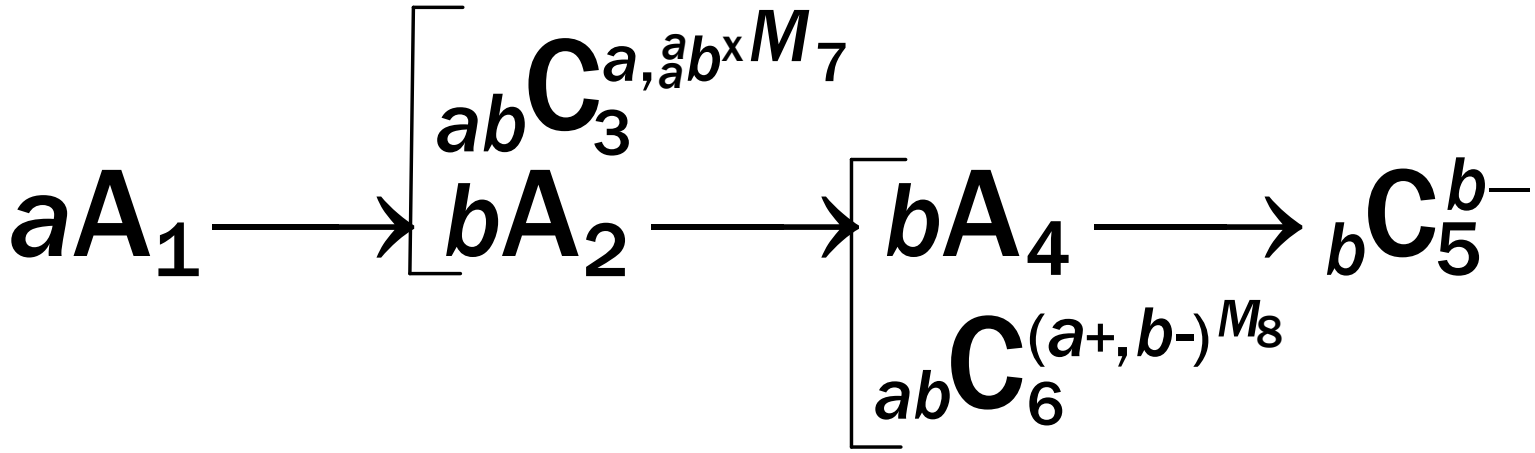
Again, ***a*** would predict and perceive ***b's misperception***.

$$aA_1 \rightarrow \begin{cases} {}_{ab}C_3^{{}_{a}^{a}(b^x)M_4} \\ bA_2 \rightarrow {}_{b}C_5^{b-} \end{cases}$$

b's response might be the purchase ($\mathbf{A_2}$) of the counterfeit with consequence $\mathbf{C_5}$.

Perpetration of a fraud

If ***a*** offers to sell ***b*** a fake painting, ***a*** would (correctly) perceive the value of the painting to be M_7 while ***b*** would misperceive its value. (b^x in the lower left of M_7.)



The ***a*** s in the two left quadrants of the b^x indicate that ***a*** would perceive as well as predict ***b***'s misperception.

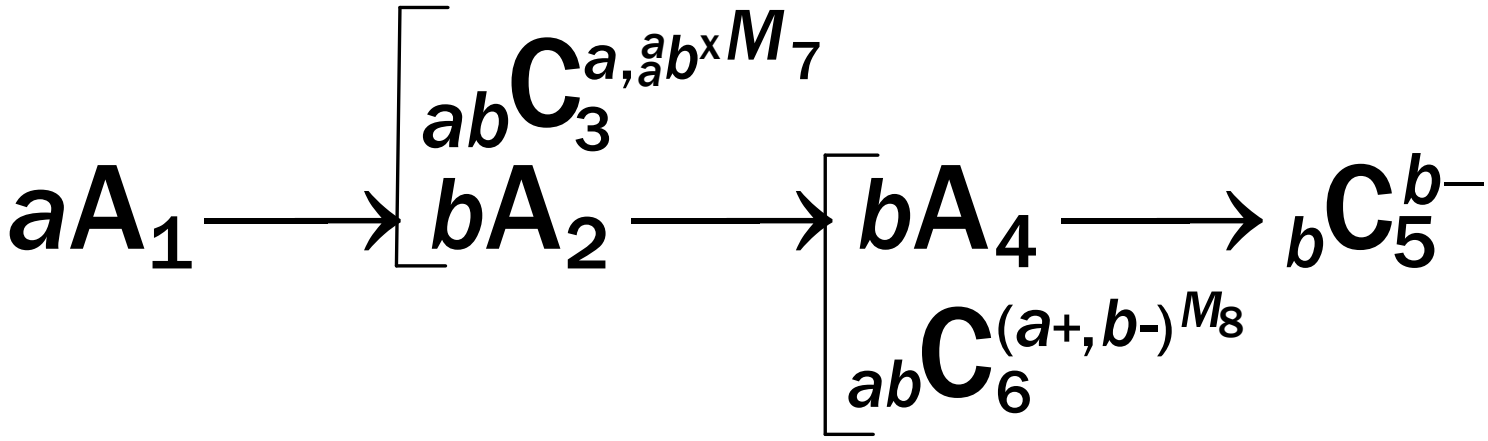
That is what makes it a fraud.

If the fraud works

C_3's pre-subscript *ab* means that both ***a*** and ***b*** perceive the painting (though they have different perceptions of its value M_7).

Suppose that ***b*** accepts ***a***'s offer aA_1 and buys the painting (bA_2), paying ***a*** the asking price M_8

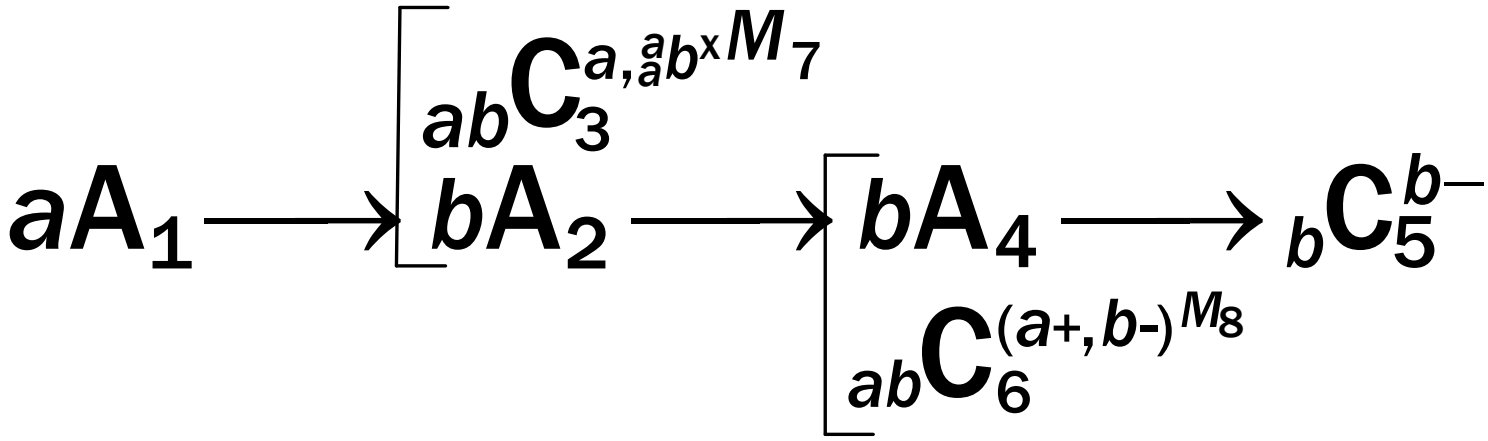
(shown as the magnitude attribute of C_6's valence.)



When *b* discovers the fraud

If ***b*** subsequently gets the painting appraised (bA_4) and learns its true value C_5, the valence of that information would be negative for ***b***.

The valence of C_6 for ***a*** would be the money (of amount M_8) that ***a*** would receive and for ***b*** it would be the money with which ***b*** would part.



A witness and accomplice

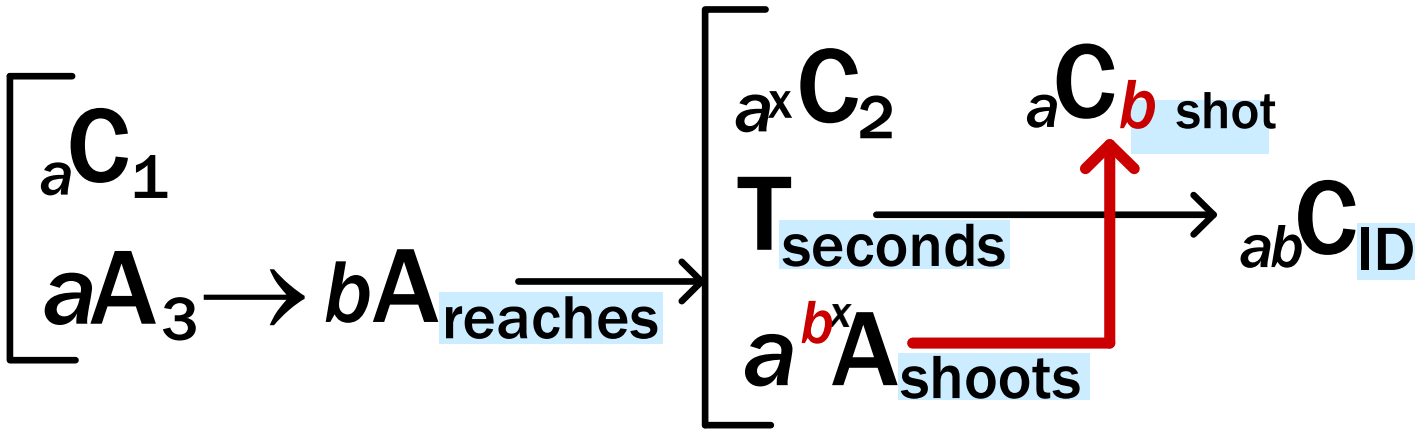
A further wrinkle could be the introduction of a third party *c* that witnesses the fraud and stands to benefit from it.

The diagram could show *c*'s choice between warning *b* or letting the fraud occur and thereby becoming an accomplice.

Unintentional Misperceptions: Mistaken identity

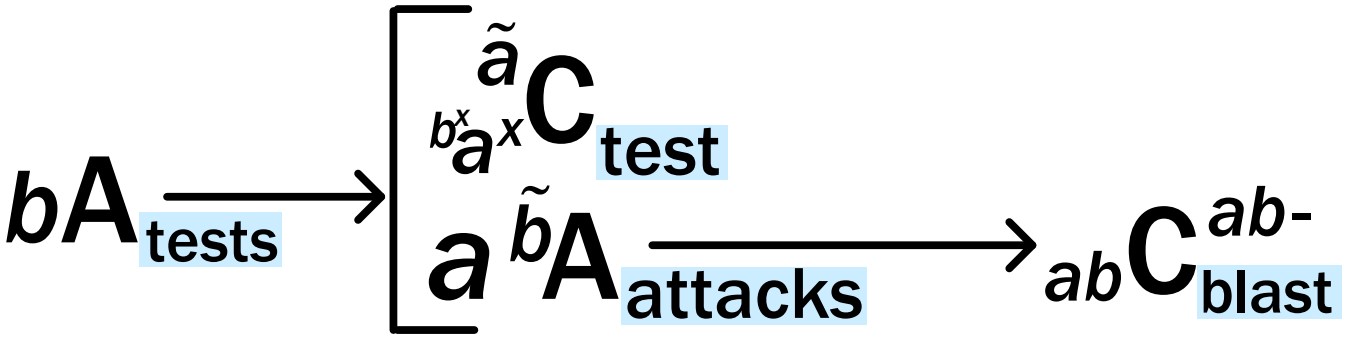
If policeman ***a*** sees a suspicious character ***b***, ($_{a}C_{1}$), he may try to arrest him (aA_{3}). If ***b*** then reaches into his pocket ($bA_{reaches}$) to pull out his identification (C_{2}), then in the T seconds this would take, the policeman could *misperceive* C_{2} and shoot ***b***.

b would be deceiving the policeman unintentionally.



Misperception of a missile test

A similar unintended deception can occur if country ***a*** misperceives a missile test by country ***b, a*** may respond with a retaliatory attack (not predicted by ***b***). The ***ã*** means that ***a*** would not predict the missile test.



The b^x in the upper left quadrant of the a^x shows that ***b*** would mispredict ***a***'s misperception.

Setting a trap

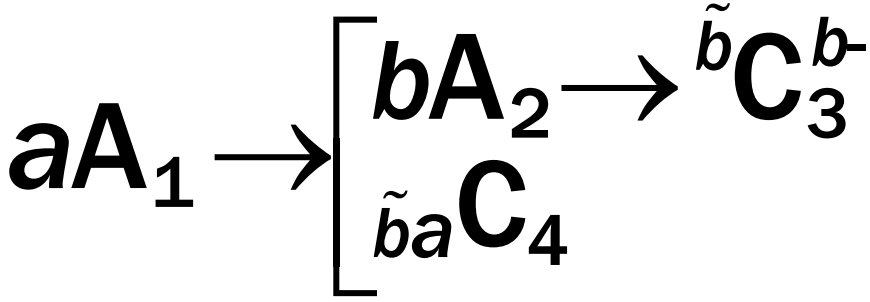
The valence of C_3 is negative for *b*, and *b* would not predict C_3^{b-} nor perceive C_4. *(Note the negation symbols $\tilde{b}$ in those positions).*

$$aA_1 \rightarrow \begin{bmatrix} bA_2 \rightarrow {}^{\tilde{b}}C_3^{b-} \\ {}_{\tilde{b}a}C_4 \end{bmatrix}$$

This shows ***a*** setting a trap for ***b***, because ***b*** does not perceive the trap (while ***a*** does) and ***b*** does not predict the negative consequence of falling into the trap. The pre-subscripts of C_4 indicate whether ***a***, ***b***, both, or neither would perceive C_4 .

Example: If a parent installs a secret video camera to monitor the baby sitter, the baby sitter would be caught if she abused the baby.

A warning



If the negation signs were removed from the ***b*** s, the diagram could mean that C_4 is a warning to ***b*** regarding bA_2 and its consequence.

If ***b*** represented a populace, the diagram would describe what is often called an advisory.

Predicting and perceiving an e-mail image

$$eA_1 \rightarrow \begin{bmatrix} aA_2 \rightarrow {}^{a}_{a}C_4 \\ {}_aC_3 \end{bmatrix} \quad \begin{bmatrix} {}^{a}_{a}C_4 \\ aA_5 \rightarrow {}^{\tilde{a}}C^{a-}_6 \end{bmatrix}$$

If ***a*** perceives that he has an e-mail, ${}_aC_3$, that was sent (eA_1) by an unidentified external agency ***e***, and

if ***a*** then opens the e-mail (aA_2), ***a*** would predict that its image (C_4) would appear on the screen, and when it does, ***a*** would perceive it.

Predicting the image but not the contingency: A computer virus

The ***a*** s in the upper and lower left quadrants of C_4 have no bearing on whether ***a*** would predict or perceive that the attachment could infect his computer with a virus.

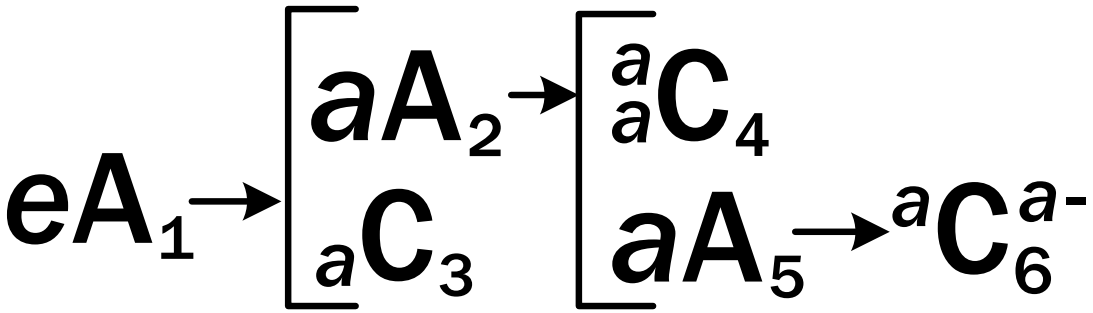
To represent that those ***a*** s would, we need to add the $aA_5 \rightarrow C_6^{a-}$ contingency, which addresses whether ***a*** would predict that aA_5 (clicking on the attachment) would infect the computer with a virus C_6^{a-}.

$$eA_1 \rightarrow \begin{bmatrix} aA_2 \rightarrow \begin{bmatrix} \overset{a}{a}C_4 \\ aA_5 \rightarrow \tilde{C}_6^{a-} \end{bmatrix} \\ {}_aC_3 \end{bmatrix}$$

Predicting a virus

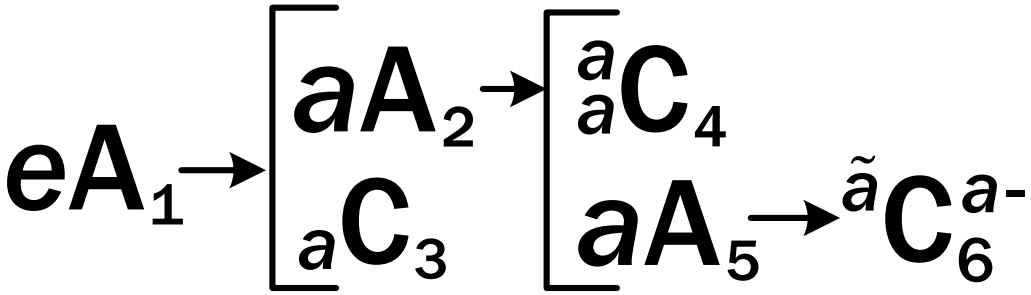
The ***ã*** in the upper left quadrant of C_6^{a-} indicates that ***a*** would not predict that opening the attachment would incur a virus.

If it were desired to show that ***a*** *would* predict it, the ***a*** would need to be shown in the upper left quadrant without the tilde, like this: ${}^{a}C_6^{a-}$



Subscripts indexed to the legend make a diagram specific to a situation

The same diagram can represent any of many possible situations in which an external agent consequates an opportunity for a party to fall into a trap.



Examples: $\boldsymbol{aA_2}$ could refer to ***a*** picking up a booby trapped object, buying a food that is contaminated or unhealthy, investing in a worthless stock, committing to an unaffordable mortgage, or an ex-addict going into a situation in which he may re-addict himself.

“AND” AND “OR” RELATIONSHIPS

"And" relationships

Mother to child, "I will read you a story (C) if you brush your teeth (A_1) and get into bed (A_2) in the next five minutes (T_3)."

Since all three conditions must be met, the "and" symbol $\cap$ is used:

$$(\mathbf{A_1} \cap \mathbf{A_2} \cap \mathbf{T_3}) \rightarrow \mathbf{C}$$

Cooperation

The ∩ symbol can show cooperation among parties.

$$(\boldsymbol{a}\mathbf{A}_1 \cap \boldsymbol{b}\mathbf{A}_2)$$

Here ***a*** and ***b*** perform different and separate acts $\boldsymbol{a}\mathbf{A}_1$ and $\boldsymbol{b}\mathbf{A}_2$ when they cooperate.

Note: The ∩ symbol is an abbreviation for showing all possible permuted sequences of the events as equivalent alternatives in consequating the same **c.**

Contracts and agreements

If two parties ***a*** and ***b*** make an agreement

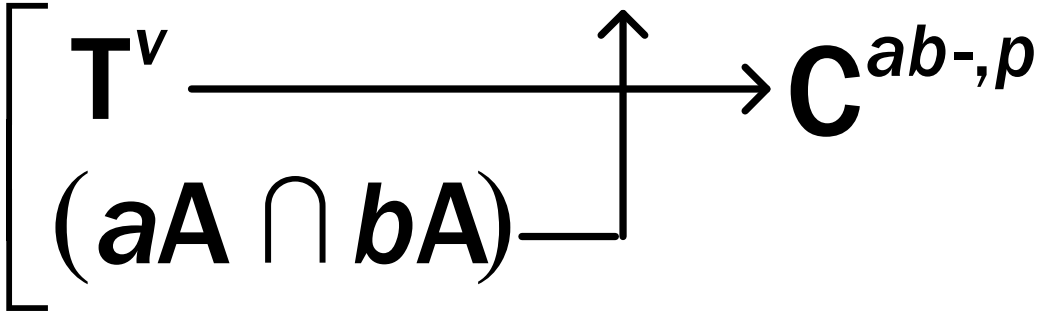
$$(\boldsymbol{a}\mathbf{A}_1 \cap \boldsymbol{b}\mathbf{A}_2)$$

by exchanging promises, undertakings, goods, signatures, or money, and each party agrees to perform further acts $(\boldsymbol{a}\mathbf{A}_3 \cap \boldsymbol{b}\mathbf{A}_4)$ to carry out the agreement, the consequence $\mathbf{C}^{\boldsymbol{ab}+}$ would benefit both parties.

$$(\boldsymbol{a}\mathbf{A}_1 \cap \boldsymbol{b}\mathbf{A}_2) \rightarrow (\boldsymbol{a}\mathbf{A}_3 \cap \boldsymbol{b}\mathbf{A}_4) \rightarrow \mathbf{C}^{\boldsymbol{ab}+}$$

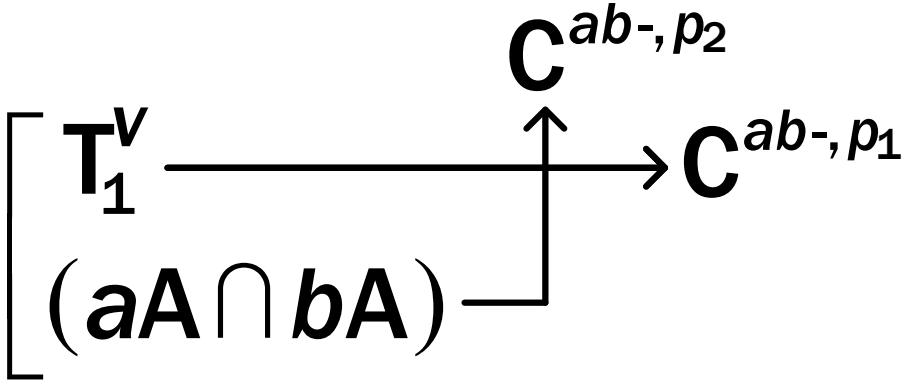
Cooperative action to avert a threat

If ***a*** and ***b*** act cooperatively (***a*A** ∩ ***b*A**) (this could mean, for example, exercising vigilance, building levees, or storing provisions), they would prevent the threat C^{ab-} which can otherwise occur after an unpredictable time T^{v}, with probability ***p***.



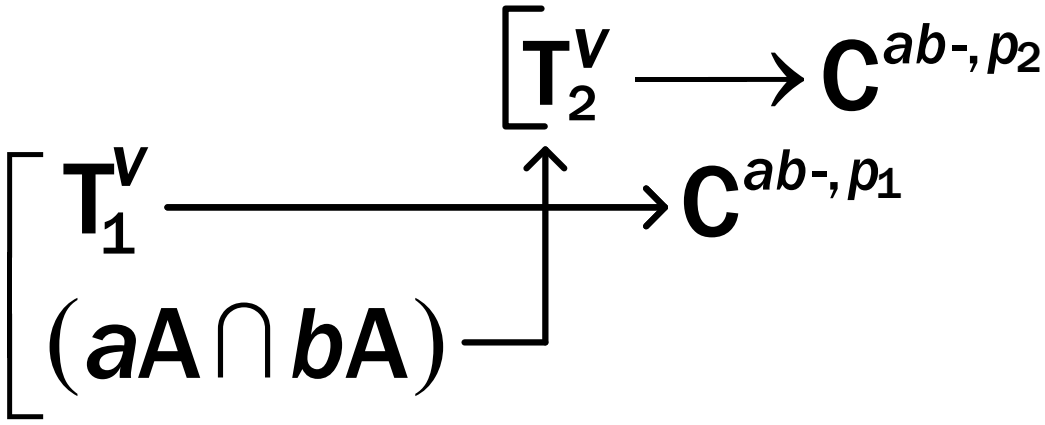
Modification of probabilities: Mitigating a danger

To show that ($\boldsymbol{aA} \cap \boldsymbol{bA}$) would merely reduces the probability of $\mathbf{C}^{ab-}$ from p_1 to p_2, rather than to zero, the consequence would be shown at the end of the vertical arrow with the new probability p_2.



Modification of contingencies

To show that (***a*A** ∩ ***b*A**) and the vertical arrow would initiate a whole new contingency, the vertical arrow would point to the bracket that encloses the new contingency.



T *in "and" relationships*

$$(aA_1 \cap T_2) \rightarrow C_3$$

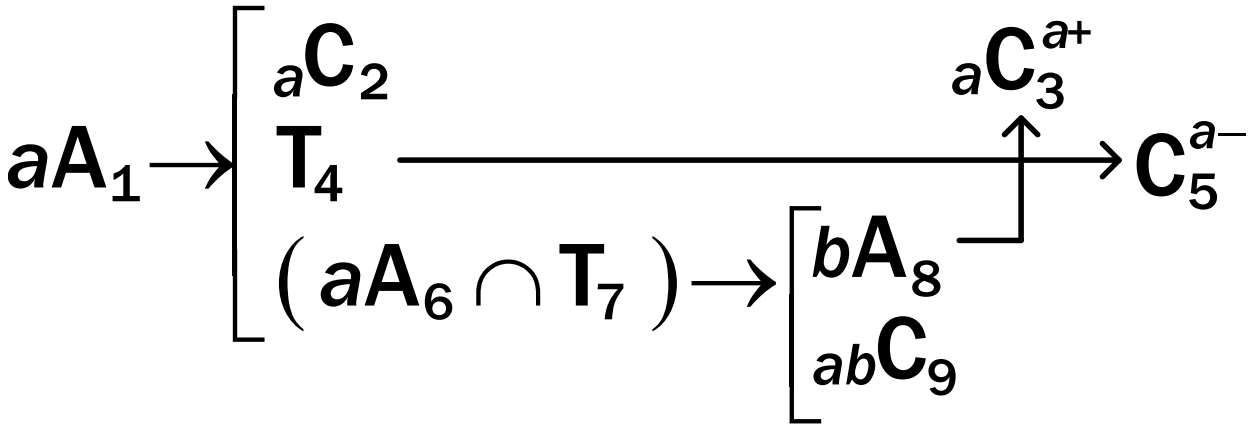
This means that if both A has occurred and T has terminated, then C. The A may occur at any time during T or after its termination.

If the A starts the T, or if A can occur only after the termination of T, you would use:

$$aA_1 \rightarrow T_2 \rightarrow C_3 \text{ or } T_1 \rightarrow aA_2 \rightarrow C_3$$

Example of T *in "and" relationships*

If you put a roast in the oven and left the house without turning the oven off (aA_1), and



if the oven is not turned off (A_8) within time T_4, the roast will burn (C_5^{a-}).

If the oven is turned off (A_8) after time T_7 and before T_4, the roast will be done.

The oven may get turned off if you ask (aA_6) your neighbor ***b*** to do so before T_4.

Conditions T_7 and aA_6 have the "and" relationship.

The legend for the roast diagram

The legend is indexed to the subscripts.

$\mathbf{aA}_1$ If you leave the roast in the oven when you go out

$\mathbf{aC}_2$ The roast would be in the oven with the oven on.

$\mathbf{T}_4$ Time after which the roast would burn.

$\mathbf{T}_7$ Time after which the roast would be done.

$\mathbf{C}_5^{a-}$ Burnt roast.

$\mathbf{aA}_6$ If you call your neighbor *b* and leave her a message.

$_{\mathbf{ab}}\mathbf{C}_9$ Message to turn off the oven after time $\mathbf{T}_7$.

$\mathbf{bA}_8\rightarrow$ If *b* turns off the oven after $\mathbf{T}_7$ and before $\mathbf{T}4$…

$\mathbf{C}_3^{a+}$ The roast would be done and $\mathbf{C}_5^{a-}$ would be averted.

Types of "or" relationships

(1) Either of two (or more) acts can result in a given consequence.

(2) A single act can result in either of two (or more) consequences.

Both can be divided into:

exclusive "or" relationships (either, or, ***but not both***) and

inclusive "or" relationships (either, or, ***or both***).

The inclusive "or" and cooperation

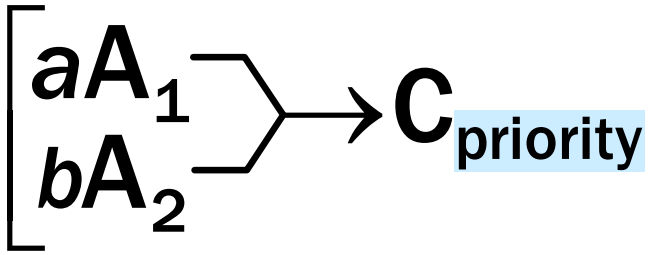
Example: **Either one of two parties, or both, can put out a fire—the inclusive "or," represented by the logic symbol U for union.**

$$(aA_1 \cup bA_2)_{\text{extinguish fire}} \rightarrow C_{\text{fire out}}$$

An exclusive "or" relationship

(Only one of two or more acts can produce the consequence)

Diagrammed by merging horizontal arrows



If two parties compete to consequate **C**,
the one who gets there first obtains the only **C**.

Example: Parties competing for priority in applying for a patent or in reaching the South Pole.

Alternative outcomes with different probabilities: Russian roulette and investing in a stock

A multi-pronged fork, with two or more arrows pointing to alternative weighted consequences, can describe contingencies in which alternative consequences have complementary probabilities.

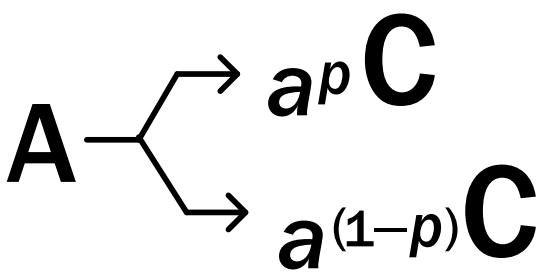
Modifiers that have "ifs" in front of them

The analyst may sometimes wish to show that a modifier like *perceive* and *predict*, or *a valence*, has an "if" in front of it.

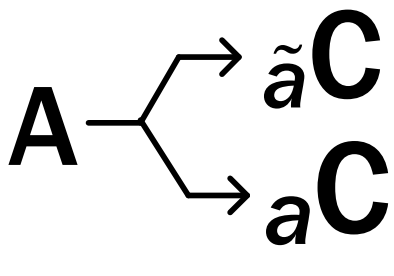
Example:

He may want $_{a}\mathbf{C}$ to be read as "If ***a*** would perceive **C**" rather than the normal "***a*** would perceive **C**."

He would then have to show the two possibilities as the two branches of an "or" fork.



or

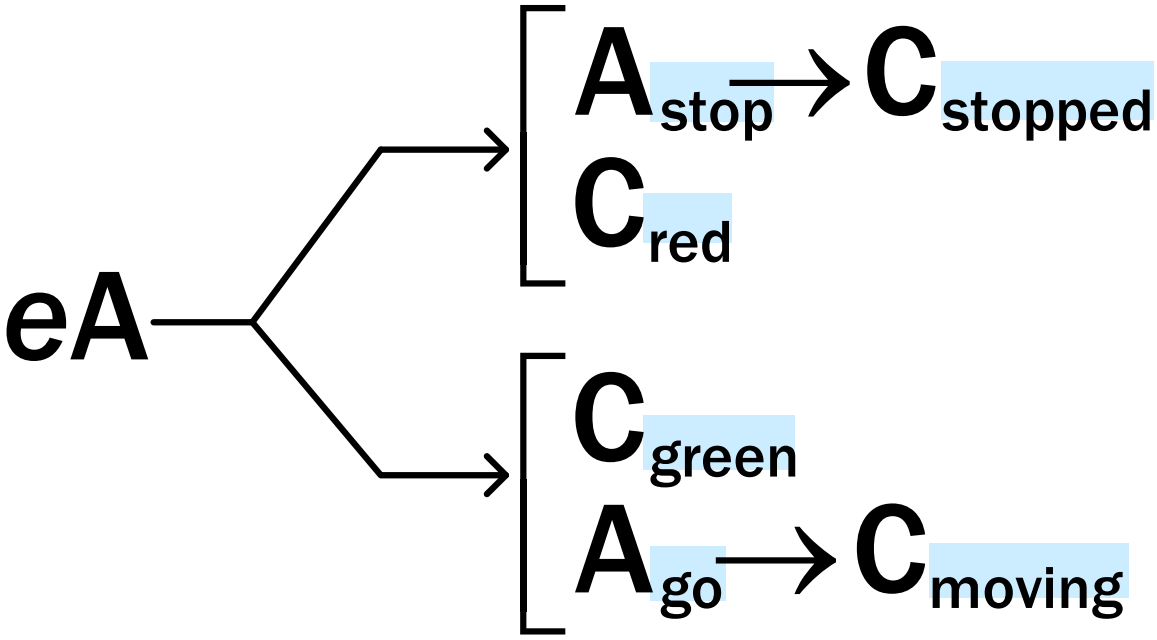


Multiple discriminations: Traffic lights

An exclusive "or" contingency:

Stop when the light is red

Go when the light is green.



CODIFYING PROBABILITIES AND UNCERTAINTIES

Predicting probabilities

When the modifier "*predicts*" is applied to a probability, the meaning is similar to that of the verb "estimates."

$$^{a}p_1$$

Party ***a*** predicts/estimates p_1.

$$a^{p_2}p_1$$

Here, p_2, an attribute of ***a***, is the probability that ***a*** predicts/estimates the probability p_1 as being p_1.

p_1 itself would usually be an attribute of some entity.

Odysseus plans a deception: The Trojan horse

"If we build a hollow wooden horse and leave it (aA_{offers}) for the Trojans to find, the Trojans (b) may (p_1) misperceive the horse and its valence.

If they then take the horse into Troy ($bA_{takes\ in}$), our soldiers hidden inside the horse may (p_3) be able to emerge during the night (aA_{emerge}) and open the gates for us to enter and sack the city."

$$aA_{offers} \rightarrow \left[{}^{a}(b^{x})^{ap_1}\tilde{b}C_{horse} \right.$$
$$\left. bA^{ap_2}_{takes\ in} \rightarrow a\,\tilde{b}A^{ap_3}_{emerge} \rightarrow C^{b\text{-}, a+, ap_4}_{sacked} \right]$$

Odysseus' plan (continued)

The b^x in $\mathbf{C}_{\mathbf{horse}}$'s lower left quadrant shows that Odysseus predicts that the Trojans would not predict this "gift" and would probably misperceive the horse.

The two $\tilde{b}$ s in the verb quadrants of $a\mathbf{A}_{\mathbf{emerge}}$ show that b would not perceive or predict the emergence of the soldiers.

The ${}^{a}p_1$ in the b^x's attribute quadrant shows that Odysseus was assigning a probability of p_1 to the misperception.

$$a\mathbf{A}_{\text{offers}} \longrightarrow \left[\begin{array}{l} {}^{a(b^x)}{}^{ap_1}{}^{\tilde{b}}\mathbf{C}_{\text{horse}} \\ b\mathbf{A}^{ap_2}_{\text{takes in}} \longrightarrow a\,{}^{\tilde{b}}_{\tilde{b}}\mathbf{A}^{ap_3}_{\text{emerge}} \end{array} \right] \longrightarrow \mathbf{C}^{b-,\, a+,\, ap_4}_{\text{sacked}}$$

Probability estimated by a party

Note that in the previous example, the $\mathbf{A}^{ap}$ probability terms refer to party ***a***'s estimation of the act's probability, not the analyst's belief.

Notation of fuzziness

A question mark after any entity's symbol indicates that the analyst is uncertain about that entity.

(The specific nature of the uncertainty, or the reason for it, can be elaborated in the legend.)

Examples:

$abA \rightarrow_{a} T \rightarrow_{(a?)b} C$ indicates that the analyst is uncertain as to whether party ***a*** would perceive the **C**.

${}_{b}C^{a+,\, b?}$ means that the analyst is uncertain as to the valence of **C** for ***b*** but not for ***a***.

Risky choices: Thinking ahead in a game

In a game of chess, checkers, or go, as well as in other types of adversarial interactions, the player takes three kinds of risk when choosing between moves or acts.

***The player is uncertain regarding*:**

(1) how accurately or completely he identified the opponent's possible responses,

(2) which of the identified responses the opponent will actually choose, and

(3) the valence of the outcome for each of these combinations of possibilities.

Thinking two moves ahead

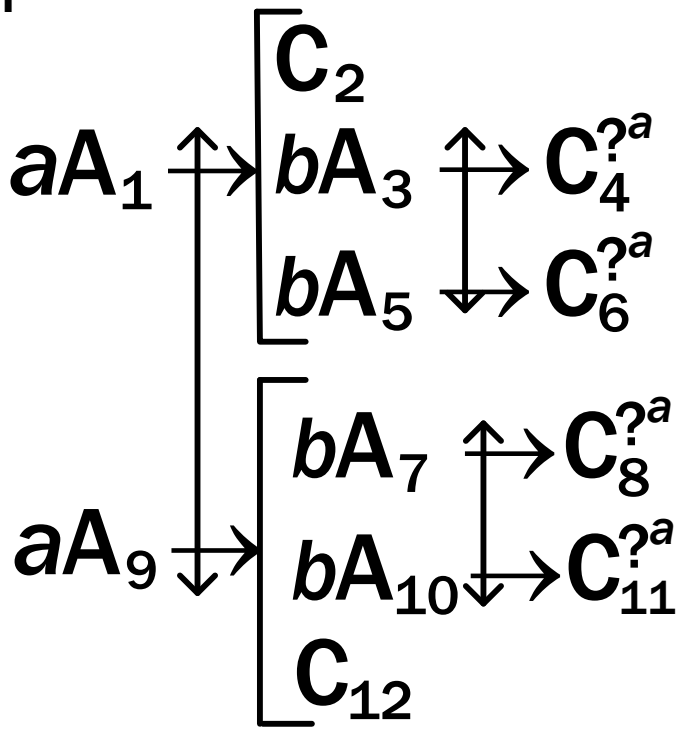
If ***a*** considers two possible moves aA_1 and aA_9, and considers ***b***'s possible responses, then

The risks:

In response to aA_1, ***b*** might choose bA_3 (a particular identified move) or bA_5 (another possible move).

In response to aA_9, ***b*** might choose bA_7 (a particular identified move) or bA_{10} (another possible move).

a would also be uncertain regarding the valences of the situations that would result if ***b*** responded in these ways.

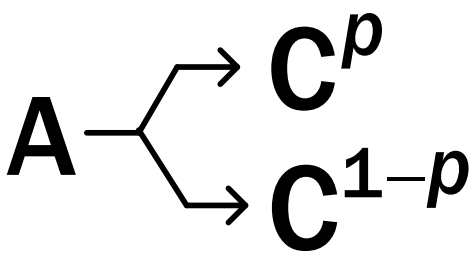


Uncertainty expressed as probabilities

$\mathbf{A} \rightarrow \mathbf{C}^{p}$ may represent a probability rather than an uncertainty.

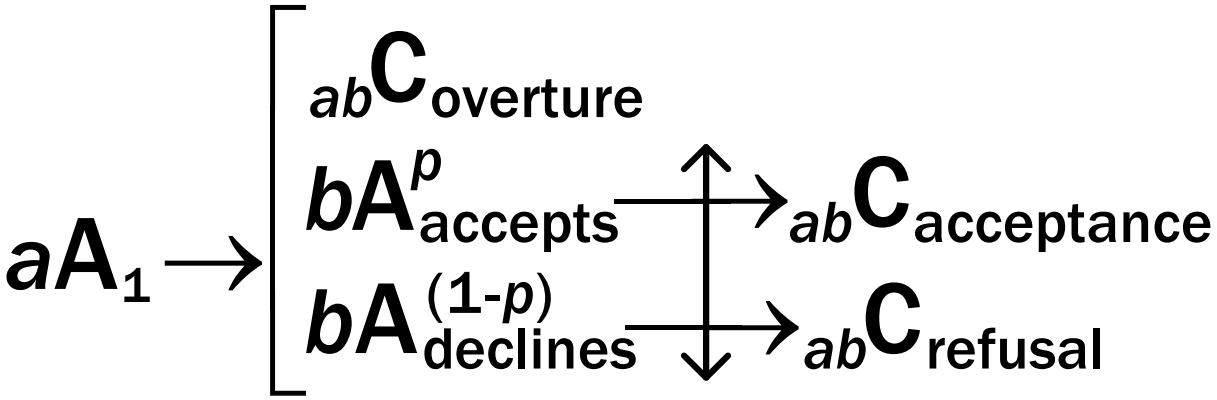
When it represents an "or" situation that implies two alternative possible consequences,

p and **1-*p*,** either of these two **C**s can be at one of the branches of an "or" fork.



Alternate points of view: A sexual overture

From *a*'s point of view, there would be two possible outcomes: Probabilities *p* that *b* would accept and 1-*p* that *b* would decline.

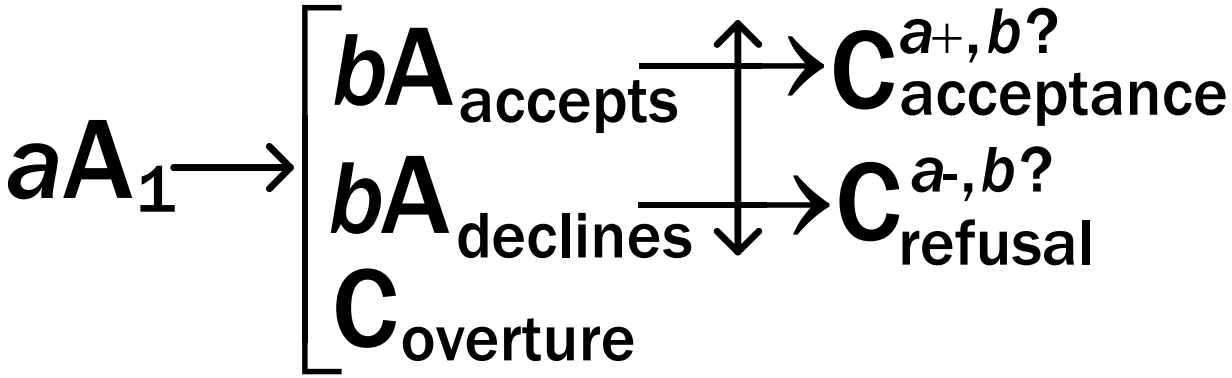


If ($bA_{accepts}$) then $_{ab}C_{acceptance}$.

If ($bA_{declines}$) then $_{ab}C_{refusal}$.

The overture from b's point of view

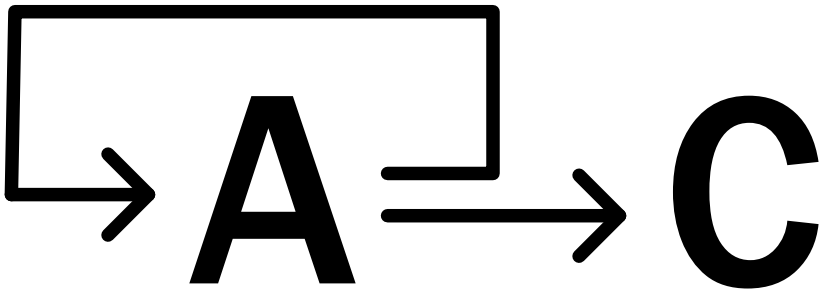
From ***b***'s point of view the issue is the decision whether to accept or decline, rather than a probability issue.



RECYCLING CONTINGENCIES AND CHANGING CONSEQUENCES

Recycling contingencies

This is a contingency that remains in effect or repeats.

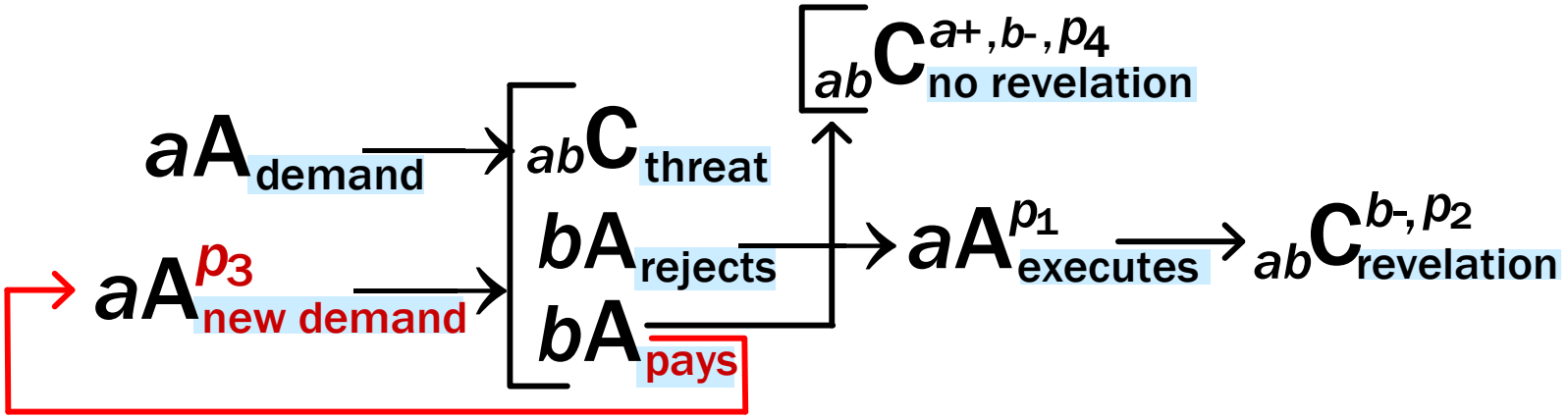


Example: If a party plays a CD, it can play it again.

Blackmail

If ***a*** threatens to reveal damaging information (revelation) about ***b*** and states that ***b*** can avert this by paying,

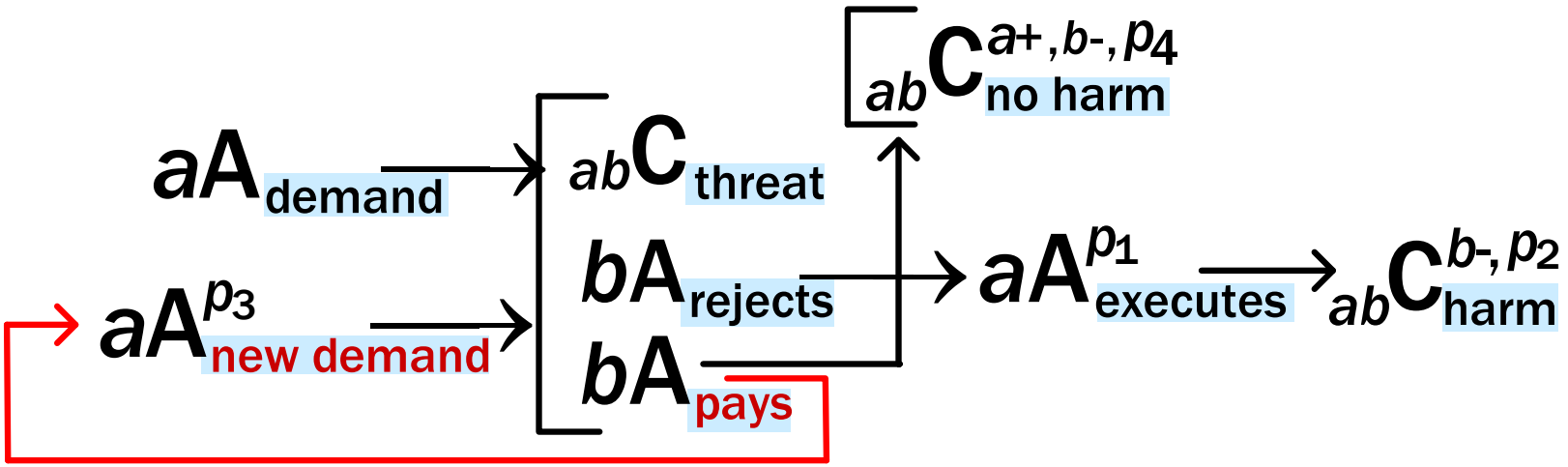
p_1 is the probability that ***a*** would execute the threat if ***b*** rejects the demand and does not make the payment,



p_3 is the probability that the entire contingency will recycle and that ***a*** will make a new demand (a consequence) even if ***b*** pays.

p_4 is the probability of no revelation if ***b*** pays.

Hostage taking or kidnapping



Legend

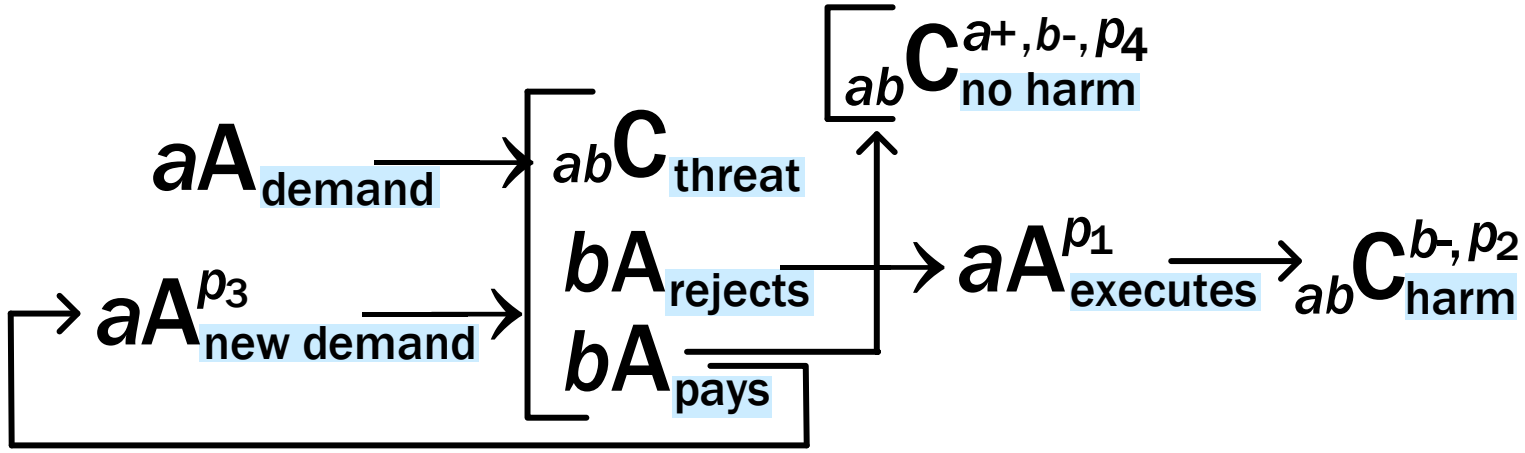
a **is the hostage taker or kidnapper.**

b **is the prisoner's people.**

$_{ab}C_{threat}$ **is the kidnapper's threat.**

$_{ab}C^{b-}_{harm}$ **is the possible harm to the prisoner.**

Hostage taking or kidnapping



Legend

p_1 probability of the threat being executed

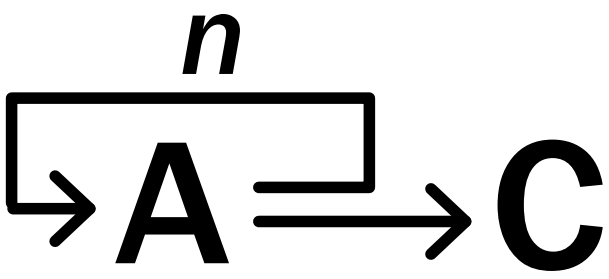
p_4 probability of averting the threat by paying

p_3 probability of recycling and future recap of the contingency if the demand is met

p_2 probability of harm if the threat is executed

Repeated recycling

To show that a contingency can recycle a number of times ***n***, the ***n*** can be written above the recycling arrow:



The use of registers

There are many contingencies in which the magnitude of a consequence keeps changing.

To show the magnitude of the consequence at every point, *a register* is required .

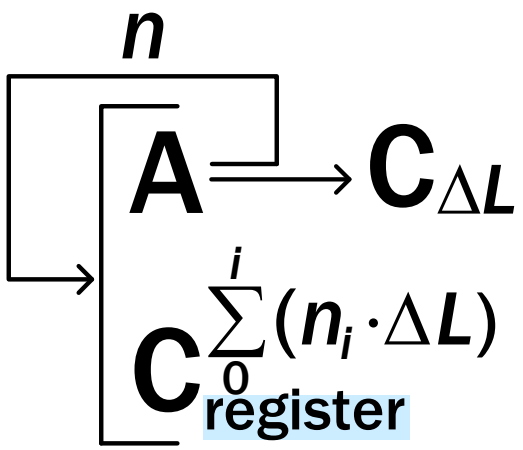
***Example*: *Pumping water into a bucket*.**

The magnitude of the consequence C is the changing water level after each successive pumping action A.

Using a hand pump to fill a bucket.

If every pumping act **A** increases the water level by one increment ΔL, then the $\mathbf{C}_{\text{register}}$ shows the amount of water in the bucket after n_i such **A** s.

The symbol Σ shows the cumulative number of times (n_i) the **A** has recycled, times the change in the water level ΔL with each cycle.



Recylings to reach criterion

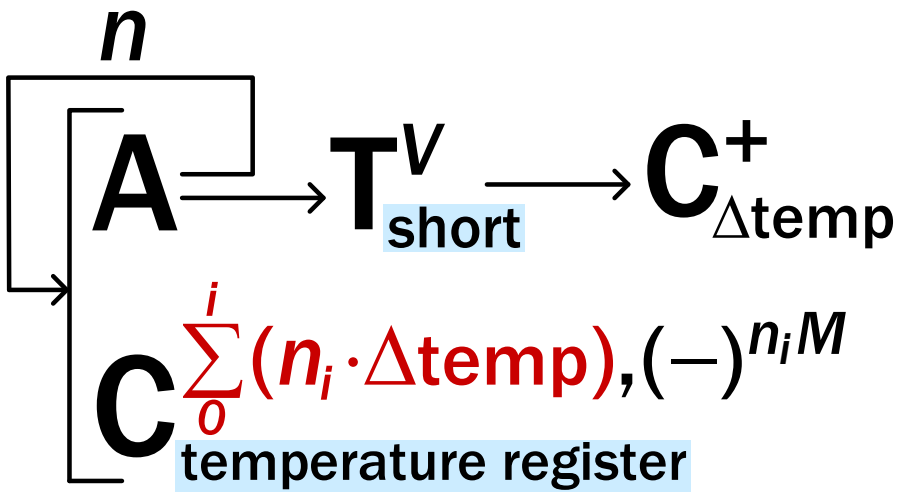
When the number of recyclings n_i is still zero, the register would show no water in the bucket yet.

The summation is always from $n = 0$ to $n = i$.

If ***10*** recyclings are needed to fill the bucket, the term $C_{full} 10 * \Delta L$ could be shown under the $C_{register}$ term, since this is already true (though not yet achieved) even before the first **A**.

Or, the legend could state that the bucket would be full when $n_i = 10$.

Short-term and long-term contingencies: Global warming



If many individual acts, like coal burning, burning of vegetation, and gasoline usage, that have short-term positive consequences $\mathbf{C^+}$, are repeated n_i times, **the long-term negative consequence** would be **a cumulative temperature change.**

Other examples of the same contingency

Long-term effects on health

- of consuming excessive sugar
- of many types of addictive behavior
- of smoking

Long-term environmental effects

- of overfishing
- of dumping wastes into waterways
- of destroying habitats

Other contingencies that require registers

- **Registering points in a game:**
  Keeping score and communicating it
- **Competition with feedback regarding progress:**
  Races, contests
- **Races without progress feedback:**
  Publication priority, product introductions
- **National elections:** ***Polls and vote counts***
- **Financial registers:** ***Accumulated interest and insurance premiums***

Variable contingencies

There are contingencies in which a consequence changes as a function of the passage of time or of some other changing variable.

Examples:

- **Ripening of a harvest**
- **Changing score in a game**
- **Depletion of a resource**
- **Loss or accumulation of money**

Magnitude as a function of a variable

When the magnitude *M* of one entity

(a consequence or valence of a consequence)

changes as a function of some variable *x*,

that change can be represented by

$$M = f(x_i)$$

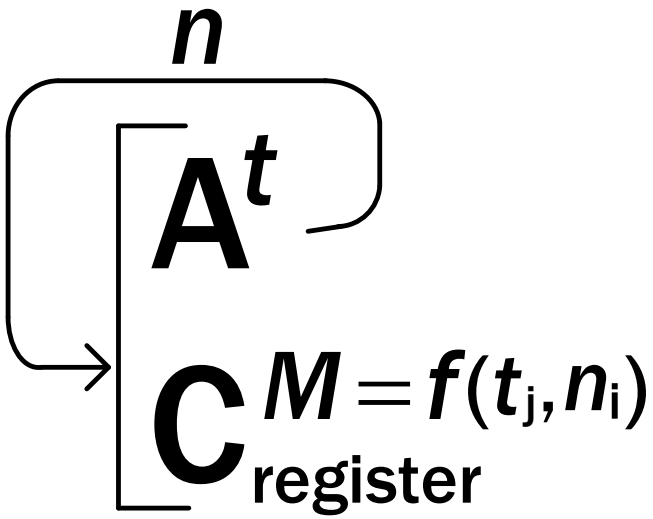
shown in the entity's attribute position.

x* *can represent elapsed time, number of repetitions, or a level reached.

x_i* *would represent some specific value of that variable.

Registers of progressive changes

Codification of contingencies that involve changes as a function *f* of n_i and t_j.



In this diagram n_i *and* t_j represent specific values of *n and t* .

Repetitions per unit of time

When $f = \Sigma(n_i / t_j)$ in some range of ***n*** and ***t***, the register shows the rate at which act **A** would be occurring at any point in that range.

Examples:

- **Experiments involving response rate**
- **Assessing proficiency in skill learning**
- **Rate of accumulation or depletion of funds**

Changes in act duration

When $f = \Sigma(t_j / n_i)$, the register could show the act's average duration after every n_i repetitions.

Examples:

- **Learning to do a job faster**
- **In behavior research, measuring response duration, latency, or IRTs**
- **Keeping track of the average time between contractions during labor**

Keeping track of repetitions

When $f = \Sigma(n_i)$, the register shows the number of time an act has been repeated at various points.

Examples:

- **Scoring points in a game**
- **Keeping track of money saved up so far**
- **Number of votes received so far**

Other types of changing contingencies

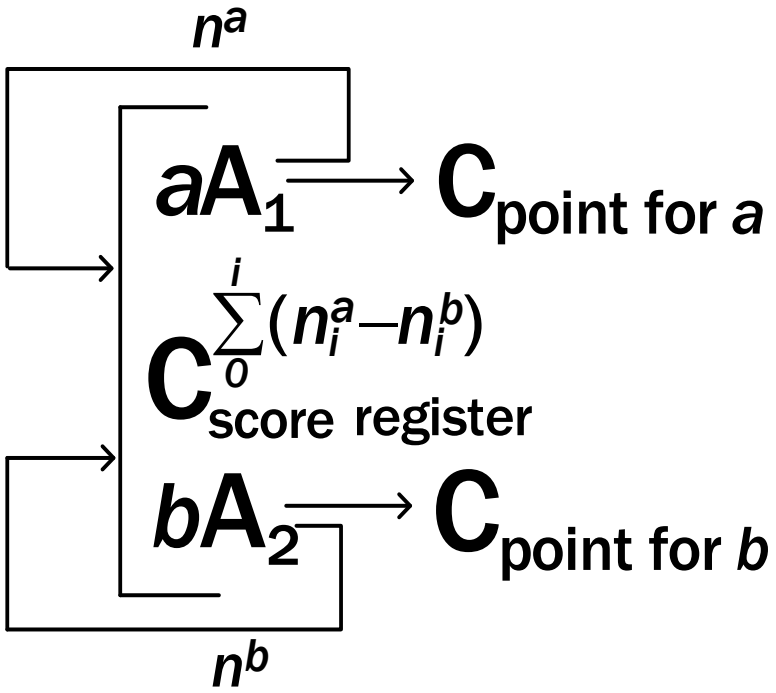
- **When $f = \Sigma(t_j)$, the register shows the elapsed time at various points, as when watching the clock or checking how long completion of a job is taking.**

- **Exponential functions can show progressive effects, as in growth, shrinkage, proliferation, or decay.**

Registering the score in a game

In many games, like basketball, soccer, and football, the winner is the team that scored the most points, often by the end of a certain time.

The $C_{\text{score register}}$'s attribute quadrant shows the difference in the scores of the two teams at every point during the game.



Races without knowledge of the opponent's progress

- Two research teams competing to be the first to publish an important discovery.
- Two corporations competing to be first to bring a new product to market.
- Athletes training for a competition.

Mutual deterrence and first strike

Each of two factions ***a*** and ***b***
can launch a first strike.

If ***a*** attacks, ***b*** will retaliate unless ***a***'s attack terminates ***b***'s ability to do so.

Such termination has probability p_1,
and vice versa p_2.

Situations involving mutual deterrence

- **Litigation**
- **Military standoffs**
- **Political campaigning**
- **Price wars**
- **Trade tariff wars**
- **Other types of fighting**

Variables in mutual deterrence

The parties' and the analyst's predictions and estimations of the probabilities that

- **a first strike will avert retaliation**
- **a retaliation will end the cycle.**

and of the magnitudes of the negative consequence of each attack for the attacked side.

DECEPTION IN ECONOMICS AND FINANCE

Deception in human affairs

Example:

Behavioral contingency analysis reveals surprising instances of deception in economics and finance.

Deception in economics and finance

A prerequisite for a behavioral contingency analysis of deception in economics and finance is

an analysis of

***the concept of property*.**

Property—A familiar type of behavioral contingency

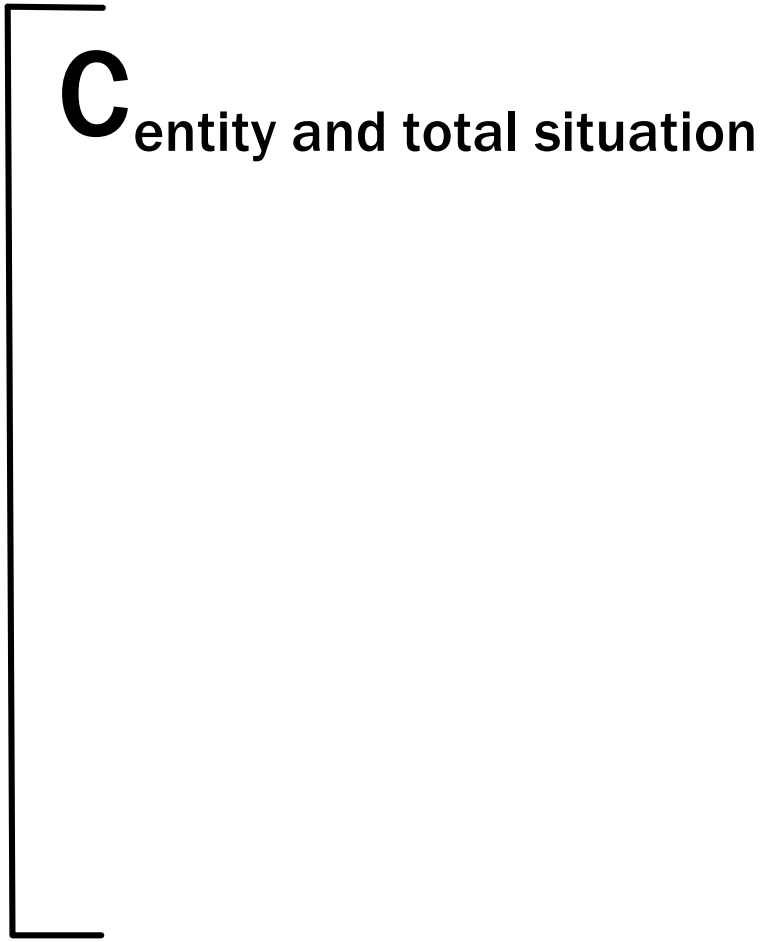
Entities (a house, a car, money, or a patent) are "property" *only insofar as they are parts of behavioral contingencies*.

A property's defining contingencies are the "owner's" and "non-owners'" available acts with respect to the entity, and the consequences that those acts would have for them.

The behavioral contingency diagram of property

The C stands for the circumstance that can include an entity like a car, a house, or a pet dog.

Suppose it's a car, and you are standing next to it with the car key in your pocket.



Ownership contingencies

Having the key does not make you the car's owner. You might have borrowed or stolen it, or you might be holding it for the owner.

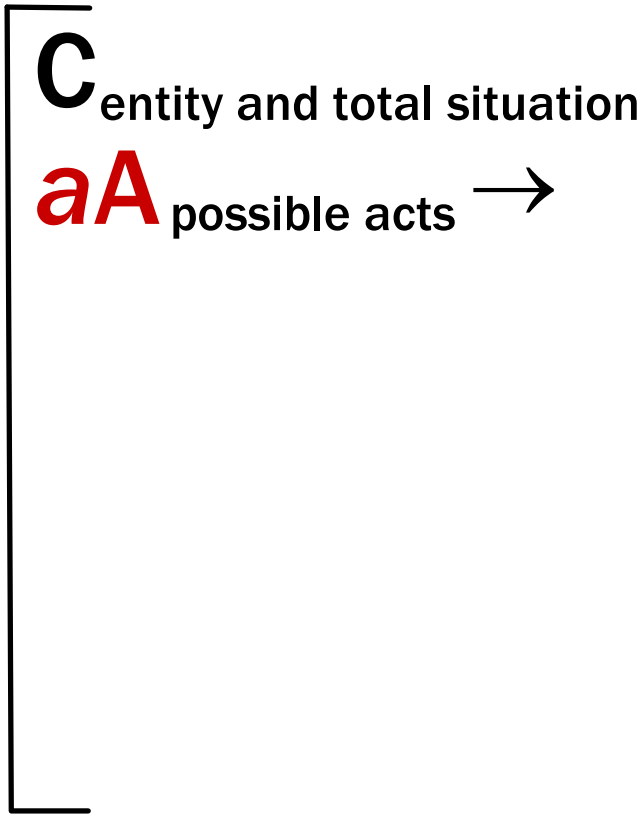
The issue of ownership depends on the operative contingencies.

Acts **A** available to ***a***

The diagram now also shows possible acts by ***a*** relating to the car in this situation.

It means:

"If ***a*** performs one of the acts **A**, then …"



a's possible acts **A** —***a***'s "rights"

a **could take the car for a long ride**

a **could park it in her garage.**

a **could go and sell it.**

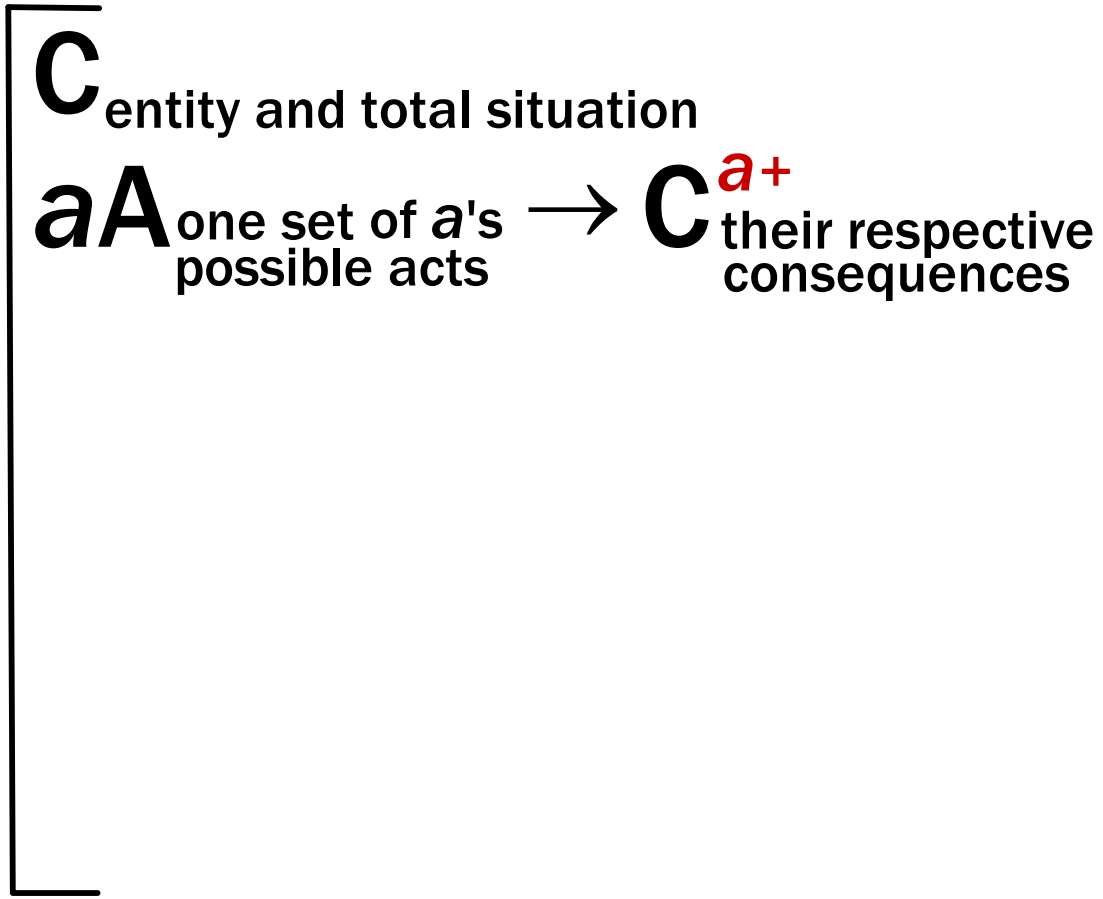
a **could lend it to a friend.**

a **could paint it a different color.**

The consequences C of all these available acts would generally be positive for *a*, and would usually be called "rights."

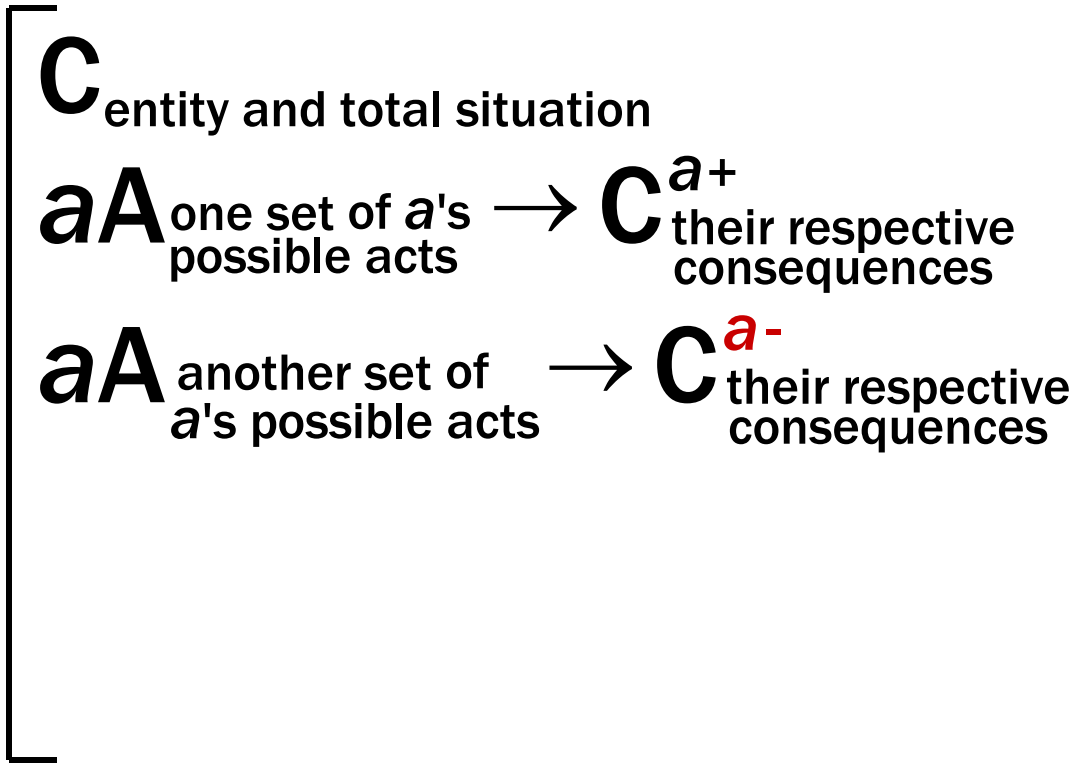
Acts that would presumably have positive consequences for *a*

Here **A** represents the set of these acts, sometimes termed ***a*'s** rights, available to ***a*** in this situation.



Acts available to *a* that have negative consequences

The second ***a*A** represents the set of all acts relating to the entity, in that same situation, that would probably have **negative consequences for *a***.



Acts available to parties *b*

All parties other than *a* (including all the rest of the world) are represented by *b*.

If a *b* party takes the car for a long drive, or puts it in their garage, or tries to sell it, or paints it a different color, or performs any other act comprising A's "rights," the consequence for *b* would be indeterminate (often negative).

Those contingencies define a "non-owner."

Possible acts by all others and their consequences

The ***b*** represents all parties other than ***a***, including the rest of the world.

$bA \rightarrow C^{b?}$ represents all of ***b***'s available acts and their indeterminate consequences.

C entity and total situation

aA one set of *a*'s available acts $\rightarrow C^{a+}$ their respective consequences

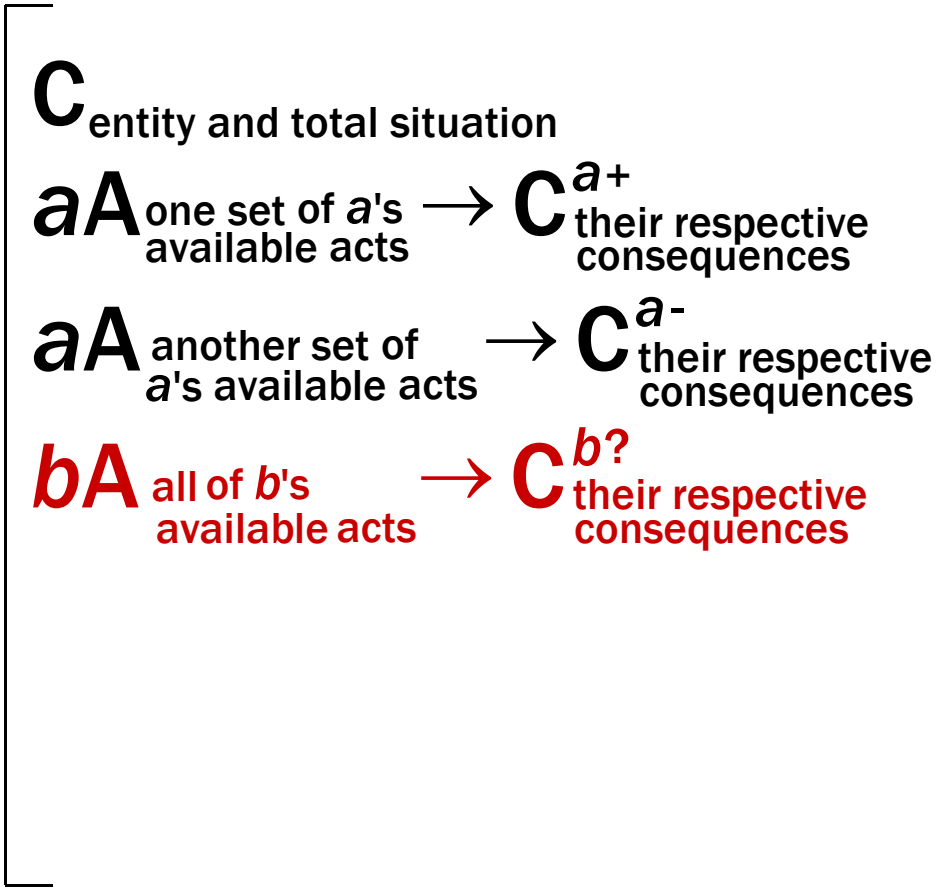
aA another set of *a*'s available acts $\rightarrow C^{a-}$ their respective consequences

bA all of *b*'s available acts $\rightarrow C^{b?}$ their respective consequences

The valence for ***b*** of the consequences of ***b***'s acts

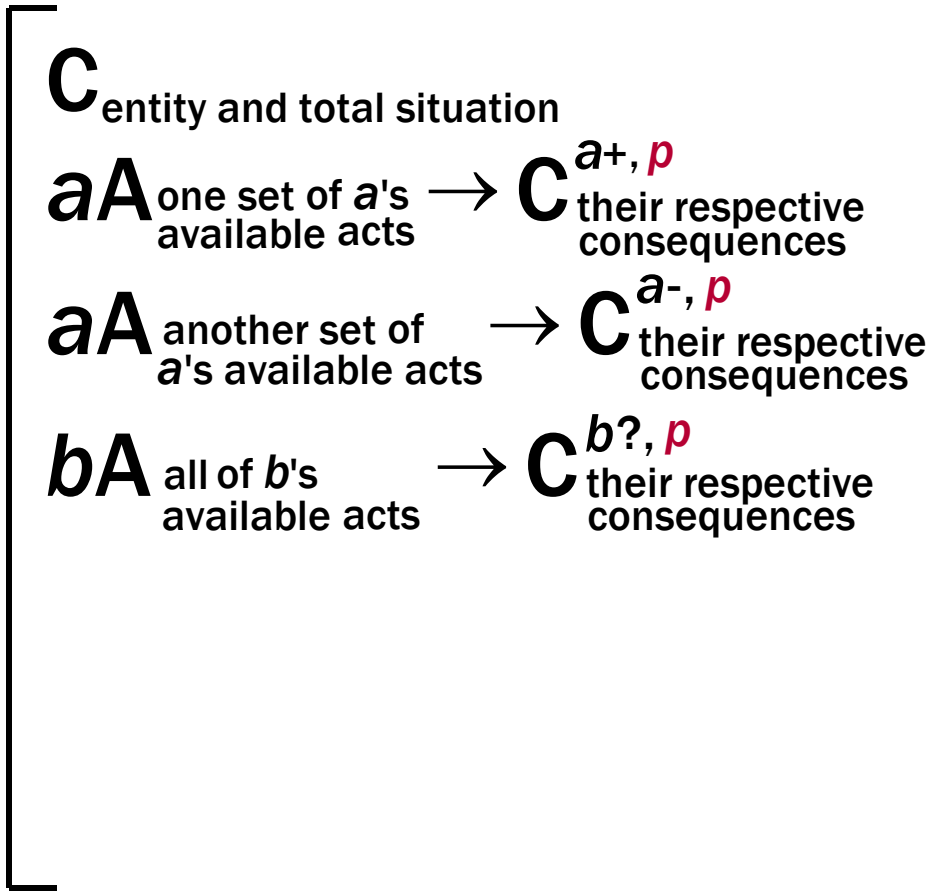
When *b* performs any of the acts available to it (including acts available to *a*, the consequence might be negative or risky for *b*, e.g., trespassing may be punished), neutral, or positive, as when *b* gets away with stealing).

Hence the ? for *b*'s valence.



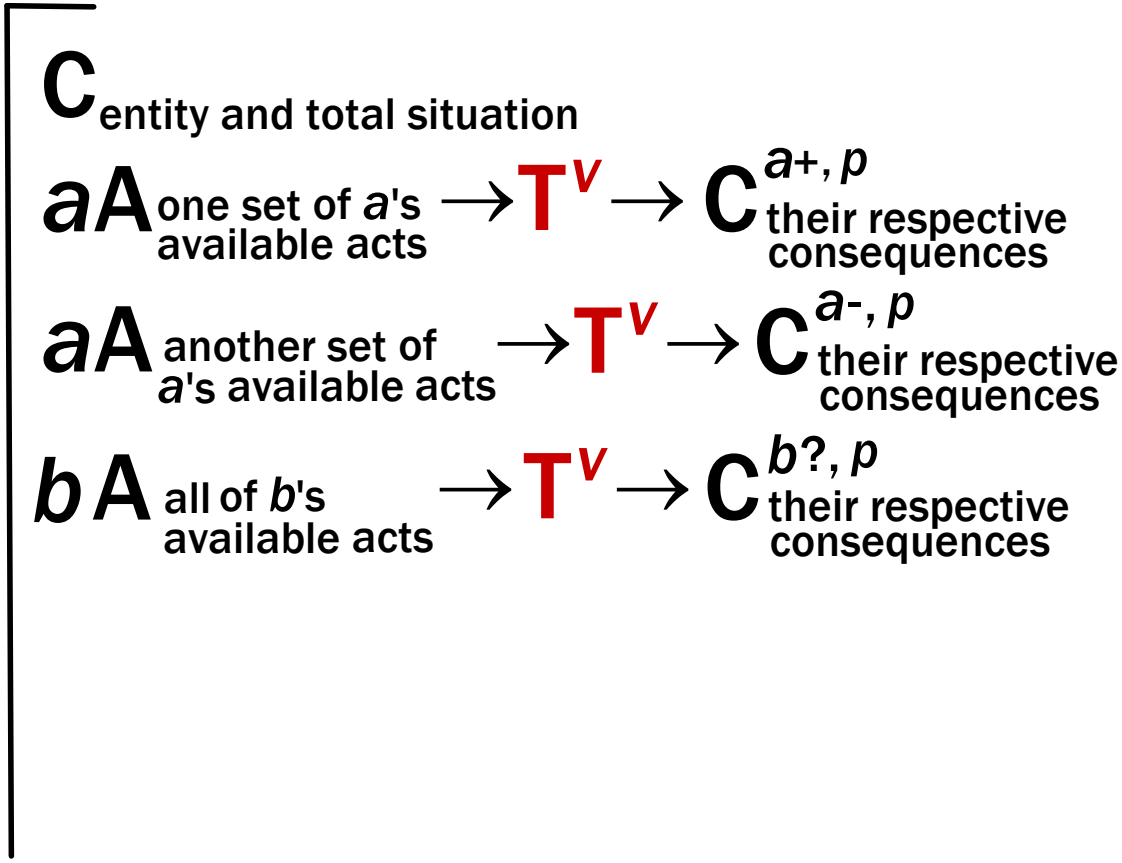
Probabilities of ***a***'s and ***b***'s available acts

The *p* s in the attribute quadrants of the Cs show that every C can be less than certain—it has a certain probability.



All consequences have variables and often unknown delays

Here the description of the contingencies includes the time delays of the consequences, since consequences are never instantaneous.



Ownership always entails obligations

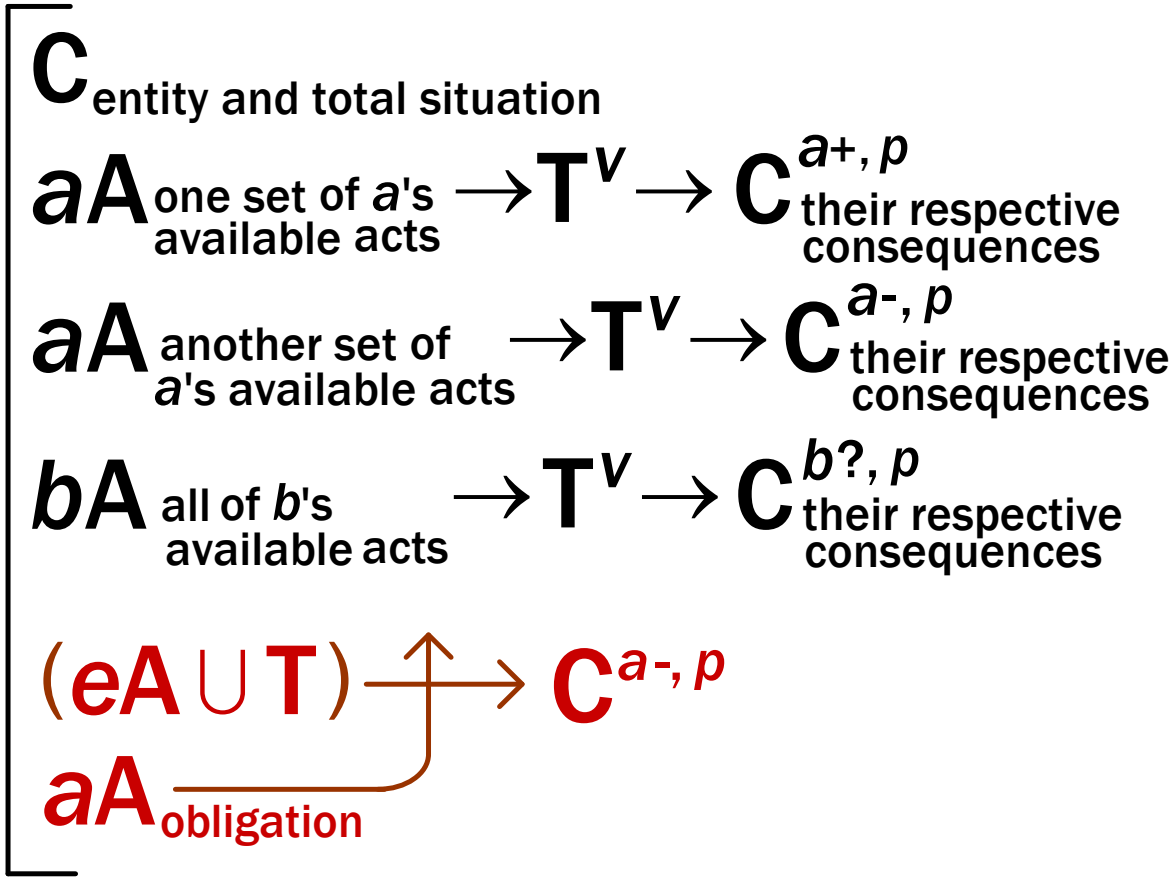
An obligation is an act that *a* must perform to avert a possible loss, sometimes a loss of ownership. The negative consequence may be the result of acts *e*A by others, or of the passage of time T.

Examples of negative consequences:

A lender repossessing the car.
A mortgage company foreclosing.
A pet running away or dying of hunger.
A tax authority attaching the property.
The driver's license being suspended.

a's obligations with respect to the entity

The obligation contingency is now added to the other contingencies that define property.



"Effective value"

The *effective value* of a property is the *valence of the predicted net consequence* of certain possible acts, taking into account the possible time delays and probability factors.

Property transfer

A ***property transfer*** **is a certain type of *change in the contingencies* that define the property.**

It can involve changes in some or all of *a*'s and *b*'s action options (rights, prohibitions, or obligations) and of their consequences, including their effective values.

Types of Property Transfer

Familiar ones are sales, gifts, loans, and sharing.

The analysis that follows shows how certain less familiar ones, namely aggregation, partitioning, and multiple-stage transfers, readily lend themselves to *deception*.

Property aggregation

Property aggregation is
one type of property transfer.
It involves "bundling" properties
into new, fewer, and larger property units.

Examples: ***The creation of***

- **funds** (hedge funds, mutual funds, money market funds)
- **conglomerates** (several merged companies)
- **derivatives** (collateralized debt obligations, asset-backed securities, credit default swap agreements)

Effects of aggregation

The aggregation process usually ***blurs, clouds, or conceals the effective value*** of the properties that were aggregated, and their original defining contingencies.

Partitioning of Property

Partitioning is another type of property transfer. It, too, clouds, blurs, or conceals the effective value of the original property and its defining behavioral contingencies.

Examples:

A developer subdividing land

A corporation issuing or splitting stock

A building going coop or condo

A government printing currency units

Selling lottery tickets

Money laundering

Money laundering is a type of multiple-stage property transfer. It, too, conceals the defining contingencies of the transferred property (usually the origin of the money).

Example of securitization

Banks *aggregated* unsound mortgages into new securities.

They then *aggregated* these new securities into further *aggregates*, which they then *partitioned* into other new securities which they then transferred to other parties.

Each stage of transfer further obfuscated the effective values of the transferred properties.

The creation of derivatives and deception

The creation of derivatives often involves partitioning, aggregation, and multiple-stage property transfers.

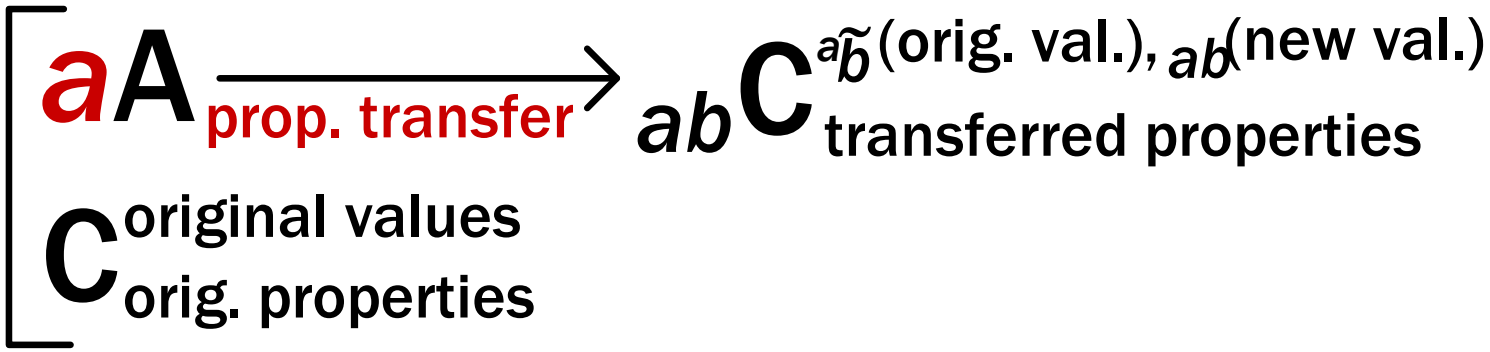
That is how derivatives provide the transferor with the opportunity to obfuscate (*cause non-perception or misperception*) of the relevant contingency history and of the Effective Values of the properties

and thereby to *deceive*.

Obfuscation in property transfer

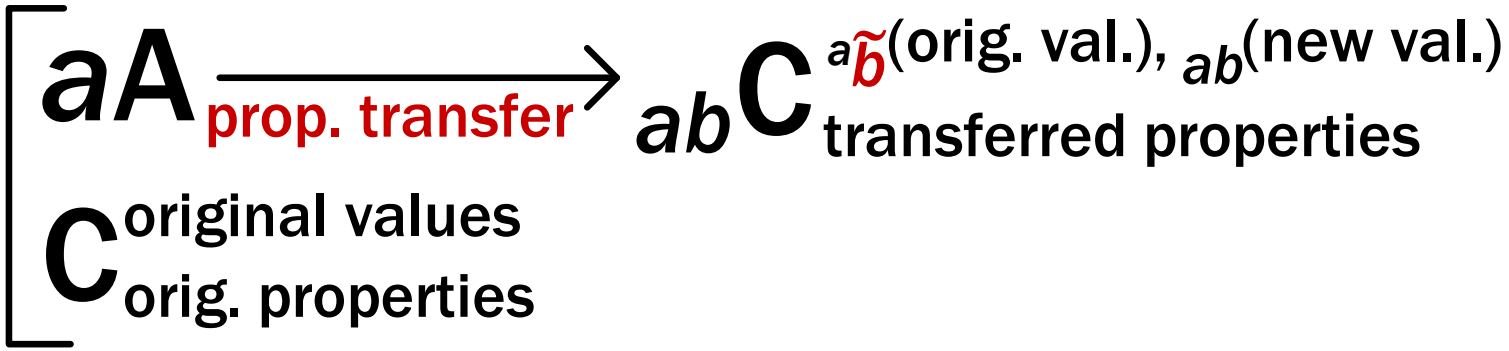
Here the transferor is *a*. The transferee is *b*.

The property transfer may be aggregation, partitioning, or multiple stage.



Obfuscation enables deception

The $\tilde{b}$ shows that ***b*** would ***not perceive***
the original values of the transferred properties,
only the new value.



The ***a*** at the upper left of $\tilde{b}$ shows that ***a*** would
predict (therefore intend) this consequence.

"Transparency" is unachievable

Aggregation, partitioning, or multiple-stage property transfers inevitably cloud and blur the contingencies that defined the original properties.

Making such property transfers "transparent" would therefore require reconstructing the defining contingencies of the original properties including probabilities, temporal delays, and Effective Values.

But this cannot be done because the needed information is no longer available.

Conclusions

In aggregation, partitioning, and multiple-stage property transfers, the inevitable clouding of the contingencies that defined the original transferred properties always creates a potential for deception.

The realization of this potential must be expected.

Madoff's Ponzi scheme

Bernard Madoff *aggregated* the properties (investments) and then *partitioned* the aggregate into:

(a) (overvalued) withdrawal rights and interest entitlements, which he issued to his investors, and

(b) funds that Madoff took for himself.

How Madoff's investors were deceived

Madoff's acts of aggregation and partitioning caused the investors to *misperceive* the value of their (overvalued) withdrawal rights and thus to *mispredict* the consequence of exercising those rights, all of which Madoff intended.

Non-deceptive Ponzi schemes

The participants in a Ponzi scheme often predict that given the world's finite funds and number of participants, the transfers must eventually end.

But at the time of a particular act, the Effective Value that the participant predicts outweighs the predicted small risk of being left holding the bag.

Long-term Ponzi contingencies

Thus Ponzi contingencies are also present in:

- **the consumption of non-renewable resources**
- **a government increasing a national debt**
- **pollution of the biosphere**

In these contingencies, the near-term versus long-term consequences are subject to temporal discounting.

CATEGORIZATION OF BEHAVIORAL CONTINGENCIES

Parallels revealed

Behavioral contingency analysis can reveal surprising parallels between seemingly unrelated behaviors.

***Example*:**

Locomotion is seen to have the same basic behavioral contingency structure as reading, listening, copying, simultaneous translation, and various other interactive behaviors.

Parallels between locomotion and complex verbal behavior

In locomotion:

While the prepared motor behavior is being executed, the next stretch of terrain is already being perceived and processed.

In reading or copying:

While the previously perceived stretch of text is still being articulated or copied, the next stretch of text is already being perceived and processed.

The categorization of contingencies

A demonstration that the same diagram can describe different contingencies helps to classify and categorize them.

Our natural languages already reflect many of the categorizations revealed by behavioral contingency analysis.

Other categorizations are often novel and suggest new conceptualizations.

The value of classification systems

The development of a taxonomy of behavioral contingencies is a step in the maturation of the behavioral sciences.

Examples of possible classifications based on structural parallels

- Blackmail and kidnapping
- Varieties of entrapment
- Misperceptions of agent identity
- Misperceptions of time
- Types of surprises
- Prediction of C without perception
- Misperceptions of valences
- Types of theft
- Types of zero sum games
- Types of choice situations
- Types of multiple discrimination
- Types of Intentionality
- Theory of mind categories
- Types and forms of deception
- Types of mispredictions of Cs
- Types of cooperation
- Contract, agreements, promises
- Types of “and” relationships
- Inclusive and exclusive “or”
- Types of probability forks
- Simple and branching choices
- Alternative points of view
- Types of recycling contingencies
- Types of variable consequences
- Short vs long-term consequences
- Types of competition
- Standoffs, deadlocks, mutual deterrence
- Types of property transfer
- Types of Ponzi schemes
- Locomotion, reading, copying

What does it all add up to?

A formal symbolic language for the analysis, codification, and categorization of behavioral contingencies is a tool for applying behavior analysis to a wide range of human affairs.

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