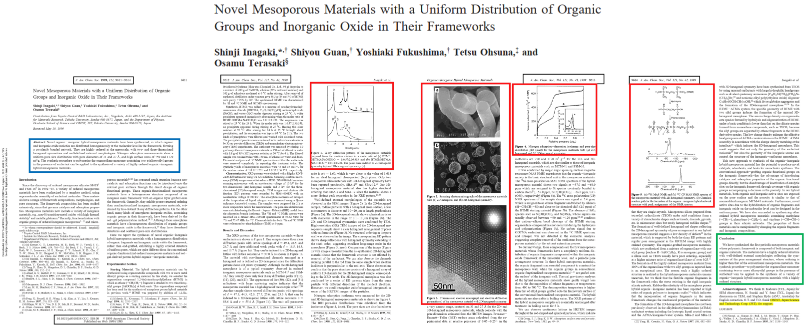
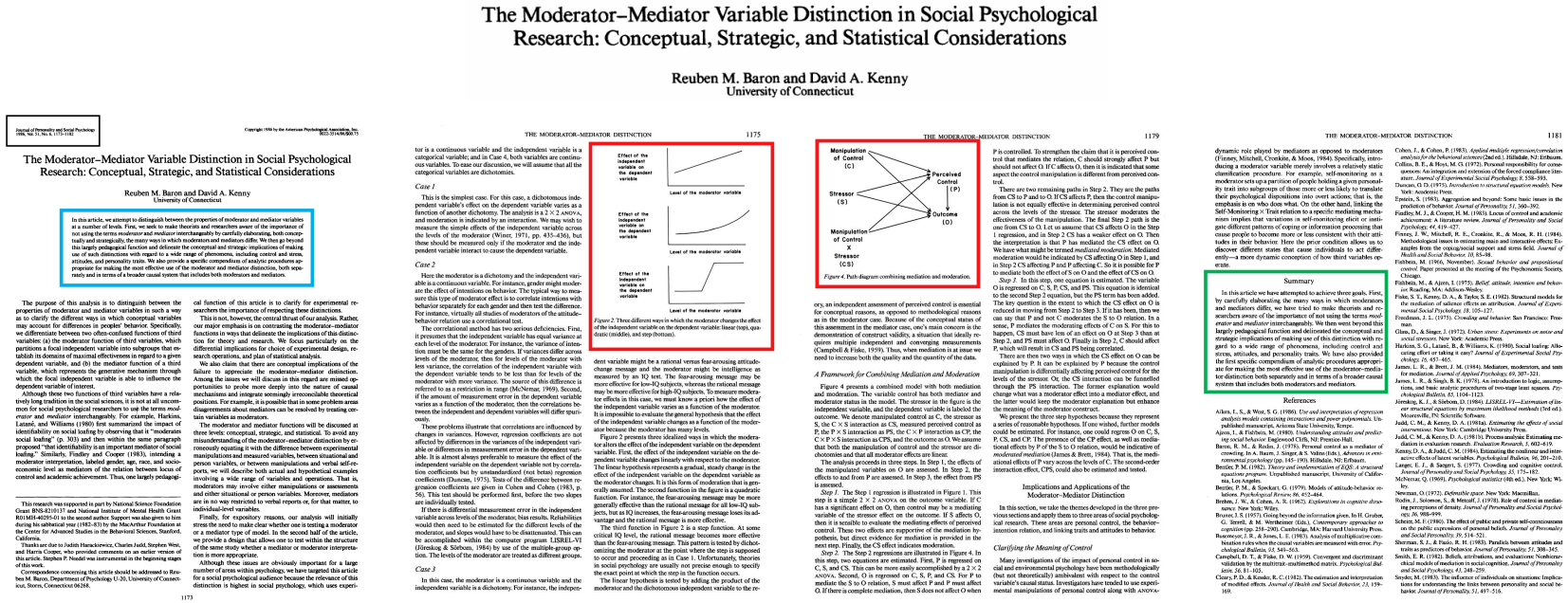

Novel Mesoporous Materials with a Uniform Distribution of Organic Groups and Inorganic Oxide in Their Frameworks

Shinji Inagaki,*,† Shiyou Guan,† Yoshiaki Fukushima,† Tetsu Ohsuna,‡ and Osamu Terasaki§

Figura: Estructura de un artículo JACS.



The Moderator–Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations

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In this article, we attempt to distinguish between the properties of moderator and mediator variables at a number of levels. First, we seek to make theorists and researchers aware of the importance of not using the terms *moderator* and *mediator* interchangeably by carefully elaborating, both conceptually and strategically, the many ways in which moderators and mediators differ. We then go beyond this largely pedagogical function and delineate the conceptual and strategic implications of making use of such distinctions with regard to a wide range of phenomena, including control and stress, attitudes, and personality traits. We also provide a specific compendium of analytic procedures appropriate for making the most effective use of the moderator and mediator distinction, both separately and in terms of a broader causal system that includes both moderators and mediators.

The purpose of this analysis is to distinguish between the properties of moderator and mediator variables in such a way as to clarify the different ways in which conceptual variables may account for differences in peoples' behavior. Specifically, we differentiate between two often-confused functions of third variables: (a) the moderator function of third variables, which partitions a focal independent variable into subgroups that establish its domains of maximal effectiveness in regard to a given dependent variable, and (b) the mediator function of a third variable, which represents the generative mechanism through which the focal independent variable is able to influence the dependent variable of interest.

Although these two functions of third variables have a relatively long tradition in the social sciences, it is not at all uncommon for social psychological researchers to use the terms *moderator* and *mediator* interchangeably. For example, Harkins, Latané, and Williams (1980) first summarized the impact of identifiability on social loafing by observing that it "moderates social loafing" (p. 303) and then within the same paragraph proposed "that identifiability is an important mediator of social loafing." Similarly, Findley and Cooper (1983), intending a moderator interpretation, labeled gender, age, race, and socioeconomic level as mediators of the relation between locus of control and academic achievement. Thus, one largely pedagogical function of this article is to clarify for experimental researchers the importance of respecting these distinctions.

This is not, however, the central thrust of our analysis. Rather, our major emphasis is on contrasting the moderator–mediator functions in ways that delineate the implications of this distinction for theory and research. We focus particularly on the differential implications for choice of experimental design, research operations, and plan of statistical analysis.

We also claim that there are conceptual implications of the failure to appreciate the moderator–mediator distinction. Among the issues we will discuss in this regard are missed opportunities to probe more deeply into the nature of causal mechanisms and integrate seemingly irreconcilable theoretical positions. For example, it is possible that in some problem areas disagreements about mediators can be resolved by treating certain variables as moderators.

The moderator and mediator functions will be discussed at three levels: conceptual, strategic, and statistical. To avoid any misunderstanding of the moderator–mediator distinction by erroneously equating it with the difference between experimental manipulations and measured variables, between situational and person variables, or between manipulations and verbal self-reports, we will describe both actual and hypothetical examples involving a wide range of variables and operations. That is, moderators may involve either manipulations or assessments and either situational or person variables. Moreover, mediators are in no way restricted to verbal reports or, for that matter, to individual-level variables.

Finally, for expository reasons, our analysis will initially stress the need to make clear whether one is testing a moderator or a mediator type of model. In the second half of the article, we provide a design that allows one to test within the structure of the same study whether a mediator or moderator interpretation is more appropriate.

Although these issues are obviously important for a large number of areas within psychology, we have targeted this article for a social psychological audience because the relevance of this distinction is highest in social psychology, which uses experi-

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tor is a continuous variable and the independent variable is a categorical variable; and in Case 4, both variables are continuous variables. To ease our discussion, we will assume that all the categorical variables are dichotomies.

Case 1

This is the simplest case. For this case, a dichotomous independent variable's effect on the dependent variable varies as a function of another dichotomy. The analysis is a 2 × 2 ANOVA, and moderation is indicated by an interaction. We may wish to measure the simple effects of the independent variable across the levels of the moderator (Winer, 1971, pp. 435–436), but these should be measured only if the moderator and the independent variable interact to cause the dependent variable.

Case 2

Here the moderator is a dichotomy and the independent variable is a continuous variable. For instance, gender might moderate the effect of intentions on behavior. The typical way to measure this type of moderator effect is to correlate intentions with behavior separately for each gender and then test the difference. For instance, virtually all studies of moderators of the attitude–behavior relation use a correlational test.

The correlational method has two serious deficiencies. First, it presumes that the independent variable has equal variance at each level of the moderator. For instance, the variance of intention must be the same for the genders. If variances differ across levels of the moderator, then for levels of the moderator with less variance, the correlation of the independent variable with the dependent variable tends to be less than for levels of the moderator with more variance. The source of this difference is referred to as a restriction in range (McNemar, 1969). Second, if the amount of measurement error in the dependent variable varies as a function of the moderator, then the correlations between the independent and dependent variables will differ spuriously.

These problems illustrate that correlations are influenced by changes in variances. However, regression coefficients are not affected by differences in the variances of the independent variable or differences in measurement error in the dependent variable. It is almost always preferable to measure the effect of the independent variable on the dependent variable not by correlation coefficients but by unstandardized (not betas) regression coefficients (Duncan, 1975). Tests of the difference between regression coefficients are given in Cohen and Cohen (1983, p. 56). This test should be performed first, before the two slopes are individually tested.

If there is differential measurement error in the independent variable across levels of the moderator, bias results. Reliabilities would then need to be estimated for the different levels of the moderator, and slopes would have to be disattenuated. This can be accomplished within the computer program LISREL-VI (Jöreskog & Sörbom, 1984) by use of the multiple-group option. The levels of the moderator are treated as different groups.

Case 3

In this case, the moderator is a continuous variable and the independent variable is a dichotomy. For instance, the independent variable might be a rational versus fear-arousing attitude-change message and the moderator might be intelligence as measured by an IQ test. The fear-arousing message may be more effective for low-IQ subjects, whereas the rational message may be more effective for high-IQ subjects. To measure moderator effects in this case, we must know a priori how the effect of the independent variable varies as a function of the moderator. It is impossible to evaluate the general hypothesis that the effect of the independent variable changes as a function of the moderator because the moderator has many levels.

Figure 2. Three different ways in which the moderator changes the effect of the independent variable on the dependent variable: linear (top), quadratic (middle), and step (bottom).

Figure 2 presents three idealized ways in which the moderator alters the effect of the independent variable on the dependent variable. First, the effect of the independent variable on the dependent variable changes linearly with respect to the moderator. The linear hypothesis represents a gradual, steady change in the effect of the independent variable on the dependent variable as the moderator changes. It is this form of moderation that is generally assumed. The second function in the figure is a quadratic function. For instance, the fear-arousing message may be more generally effective than the rational message for all low-IQ subjects, but as IQ increases, the fear-arousing message loses its advantage and the rational message is more effective.

The third function in Figure 2 is a step function. At some critical IQ level, the rational message becomes more effective than the fear-arousing message. This pattern is tested by dichotomizing the moderator at the point where the step is supposed to occur and proceeding as in Case 1. Unfortunately, theories in social psychology are usually not precise enough to specify the exact point at which the step in the function occurs.

The linear hypothesis is tested by adding the product of the moderator and the dichotomous independent variable to the re-

Figure 4. Path diagram combining mediation and moderation.

ory, an independent assessment of perceived control is essential for conceptual reasons, as opposed to methodological reasons as in the moderator case. Because of the conceptual status of this assessment in the mediator case, one's main concern is the demonstration of construct validity, a situation that ideally requires multiple independent and converging measurements (Campbell & Fiske, 1959). Thus, when mediation is at issue we need to increase both the quality and the quantity of the data.

A Framework for Combining Mediation and Moderation

Figure 4 presents a combined model with both mediation and moderation. The variable control has both mediator and moderator status in the model. The stressor in the figure is the independent variable, and the dependent variable is labeled the outcome. We denote manipulated control as C, the stressor as S, the C × S interaction as CS, measured perceived control as P, the P × S interaction as PS, the C × P interaction as CP, the C × P × S interaction as CPS, and the outcome as O. We assume that both the manipulation of control and the stressor are dichotomies and that all moderator effects are linear.

The analysis proceeds in three steps. In Step 1, the effects of the manipulated variables on O are assessed. In Step 2, the effects to and from P are assessed. In Step 3, the effect from PS is assessed.

Step 1. The Step 1 regression is illustrated in Figure 1. This step is a simple 2 × 2 ANOVA on the outcome variable. If C has a significant effect on O, then control may be a mediating variable of the stressor effect on the outcome. If S affects O, then it is sensible to evaluate the mediating effects of perceived control. These two effects are supportive of the mediation hypothesis, but direct evidence for mediation is provided in the next step. Finally, the CS effect indicates moderation.

Step 2. The Step 2 regressions are illustrated in Figure 4. In this step, two equations are estimated. First, P is regressed on C, S, and CS. This can be more easily accomplished by a 2 × 2 ANOVA. Second, O is regressed on C, S, P, and CS. For P to mediate the S to O relation, S must affect P and P must affect O. If there is complete mediation, then S does not affect O when P is controlled. To strengthen the claim that it is perceived control that mediates the relation, C should strongly affect P but should not affect O. If C affects O, then it is indicated that some aspect the control manipulation is different from perceived control.

There are two remaining paths in Step 2. They are the paths from CS to P and to O. If CS affects P, then the control manipulation is not equally effective in determining perceived control across the levels of the stressor. The stressor moderates the effectiveness of the manipulation. The final Step 2 path is the one from CS to O. Let us assume that CS affects O in the Step 1 regression, and in Step 2 CS has a weaker effect on O. Then the interpretation is that P has mediated the CS effect on O. We have what might be termed *mediated moderation*. Mediated moderation would be indicated by CS affecting O in Step 1, and in Step 2 CS affecting P and P affecting C. So it is possible for P to mediate both the effect of S on O and the effect of CS on O.

Step 3. In this step, one equation is estimated. The variable O is regressed on C, S, P, CS, and PS. This equation is identical to the second Step 2 equation, but the PS term has been added. The key question is the extent to which the CS effect on O is reduced in moving from Step 2 to Step 3. If it has been, then we can say that P and not C moderates the S to O relation. In a sense, P mediates the moderating effects of C on S. For this to happen, CS must have less of an effect on O at Step 3 than at Step 2, and PS must affect O. Finally in Step 2, C should affect P, which will result in CS and PS being correlated.

There are then two ways in which the CS effect on O can be explained by P. It can be explained by P because the control manipulation is differentially affecting perceived control for the levels of the stressor. Or, the CS interaction can be funnelled through the PS interaction. The former explanation would change what was a moderator effect into a mediator effect, and the latter would keep the moderator explanation but enhance the meaning of the moderator construct.

We present the three step hypotheses because they represent a series of reasonable hypotheses. If one wished, further models could be estimated. For instance, one could regress O on C, S, P, CS, and CP. The presence of the CP effect, as well as mediational effects by P of the S to O relation, would be indicative of *moderated mediation* (James & Brett, 1984). That is, the mediational effects of P vary across the levels of C. The second-order interaction effect, CPS, could also be estimated and tested.

Implications and Applications of the Moderator–Mediator Distinction

In this section, we take the themes developed in the three previous sections and apply them to three areas of social psychological research. These areas are personal control, the behavior–intention relation, and linking traits and attitudes to behavior.

Clarifying the Meaning of Control

Many investigations of the impact of personal control in social and environmental psychology have been methodologically (but not theoretically) ambivalent with respect to the control variable's causal status. Investigators have tended to use experimental manipulations of personal control along with ANOVA-

dynamic role played by mediators as opposed to moderators (Finney, Mitchell, Cronkite, & Moos, 1984). Specifically, introducing a moderator variable merely involves a relatively static classification procedure. For example, self-monitoring as a moderator sets up a partition of people holding a given personality trait into subgroups of those more or less likely to translate their psychological dispositions into overt actions; that is, the emphasis is on who does what. On the other hand, linking the Self-Monitoring ↔ Trait relation to a specific mediating mechanism implies that variations in self-monitoring elicit or instigate different patterns of coping or information processing that cause people to become more or less consistent with their attitudes in their behavior. Here the prior condition allows us to discover different states that cause individuals to act differently—a more dynamic conception of how third variables operate.

Summary

In this article we have attempted to achieve three goals. First, by carefully elaborating the many ways in which moderators and mediators differ, we have tried to make theorists and researchers aware of the importance of not using the terms *moderator* and *mediator* interchangeably. We then went beyond this largely pedagogical function and delineated the conceptual and strategic implications of making use of this distinction with regard to a wide range of phenomena, including control and stress, attitudes, and personality traits. We have also provided the first specific compendium of analytic procedures appropriate for making the most effective use of the moderator–mediator distinction both separately and in terms of a broader causal system that includes both moderators and mediators.

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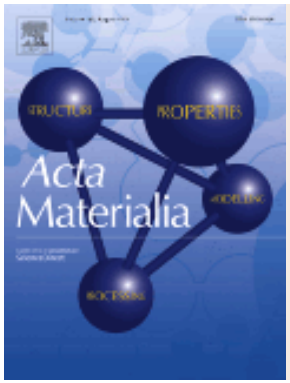
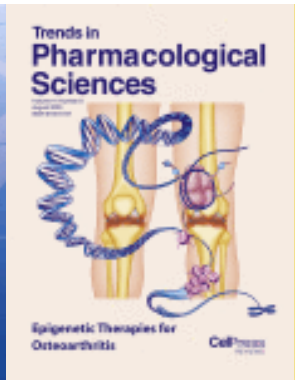
Figura: Estructura de un artículo de psicología.

Figura: Hemeroteca, bibliotéca de revistas.



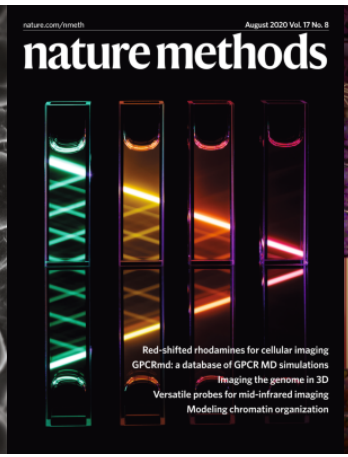
Metalurgia



Farmacia

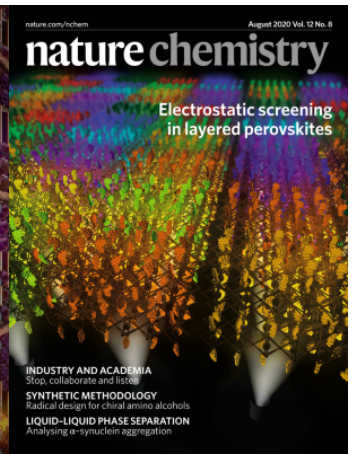
Minas

Energías
Renovables



Biología

Ingeniería
Química



Química

Figura: Las mejores revistas de acuerdo al área, agosto de 2020.

Editoriales

¿Dónde leer?

Parámetros de relevancia. Se publican con una temporalidad anual.

- CiteScore

$$CS_x = \frac{\sum_1^m c_i}{\sum_1^n i} \quad \in \quad [x-1, x] \tag{1}$$

Donde x es el año del indicador, i son los artículos de la revista, y c_i son las citas del artículo i-ésimo

¿Dónde leer?

- Impact Factor

$$IF_x = \frac{\sum_1^m c_i}{\sum_1^n i} \quad donde \quad c \in [x]; i \in [x-1, x] \qquad (2)$$

- 5-y Impact Factor

$$5yIF_x = \frac{\sum_1^m c_i}{\sum_1^n i} \quad donde \quad c \in [x]; i \in [x-5, x] \qquad (3)$$

¿Dónde leer?

- SNIP (Impacto de la revista normalizado por artículo)

$$SNIP_x = \frac{\sum_1^m c_i}{\bar{c}} \quad \in \quad [x-3, x] \tag{4}$$

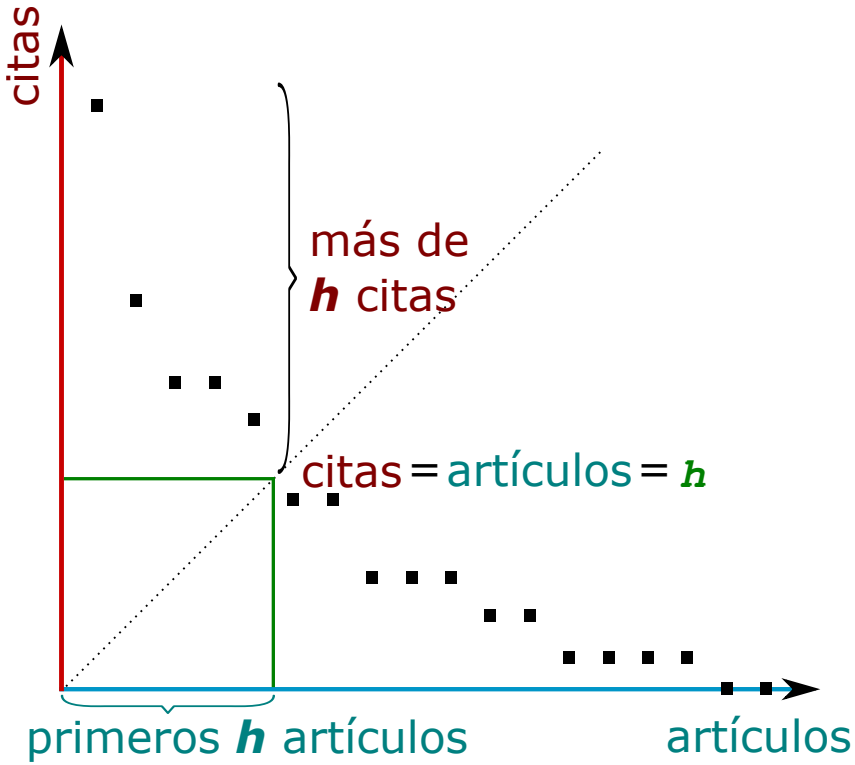
- SJR

$$SJR_x = \frac{\sum_1^m c_i \gamma_j}{\sum_1^n i} \quad donde \quad c \in [x]; i \in [x-1, x] \tag{5}$$

Donde $\bar{c}$ es el promedio de citas de las revistas del área temática, y γ_j es un factor de ponderación de la relevancia de la revista donde se cita el artículo i-ésimo.

¿Dónde leer?

- Índice H



¿Dónde publicar?

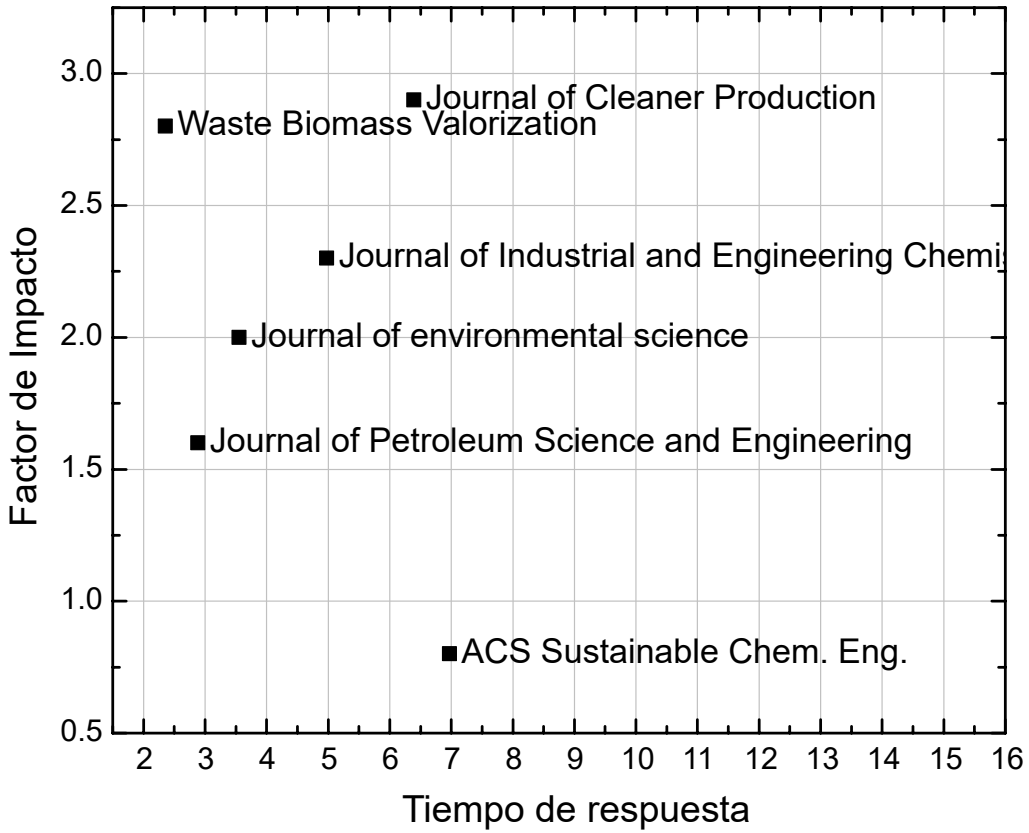


Figura: Gráfico de factor de impacto *vs* tiempo de respuesta.

Tiempos de respuesta

- https://www.researchgate.net/post/Is_there_any_collected_information_on_the_speed_of_different_journals_either_time_to_first_decision_or_time_from_acceptance_to_appearance_online
- https://scirev.org/journal/advances-in-colloid-and-interface-science/
- https://blog.dhimmel.com/plos-and-publishing-delays/